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ABSTRACT

The objectives of this study were to find out how the characteristics of students and their training affect the rate of return to investment in vocational training, how they affect the earnings of trainees, and how vocational training influences the distribution of income among educational groups. The data were collected in a previous study and consisted of detailed records for 127 vocationally trained subjects and 127 individually matched untrained subjects. Records for 411 vocationally trained subjects were used for the analysis of earnings. The data were analyzed by analysis of covariance and multiple regression analysis. One strong relationship uncovered was the negative association between I.Q. and benefits from vocational training. Some conditions among former vocational students that were found to be related to relatively higher income potential were: (1) study in health occupations, (2) being of the male sex, (3) working at a job requiring specific training, and (4) being a high school graduate. It was found that training led to similar proportionate income gains among the educationally deprived as well as high school graduates. (GEB)

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AN ANALYSIS OF DIFFERENTIAL BENEFITS FROM VOCATIONAL TRAINING

April 1971

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ABSTRACT

The labor force experience of a sample of former area vocational-technical school (AVTS) students was investigated to determine (a) the rate of return to AVTS training among various categories of students; (b) average income levels of various categories of students; (c) whether or not AVTS training tended to equalize expected income differences between dropouts and high school graduates.

(a) The sample rate of return averaged 6.3 percent, was highest among those with low ability, those who received other related training after AVTS departure, those married, and those receiving fifteen months or less training.

(b) Average income (disregarding cost of training) was highest among those with health occupation training for females (males did not differ significantly with respect to type of training), among males, those working at skilled or semi-skilled jobs, those geographically mobile, those married, and among high school graduates.

(c) The administration of AVTS training to an educationally diverse sample tended to increase expected income of both dropout and graduate in ratio to expected earnings rather than by a constant sum.

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Final Report

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Memphis State University
Memphis, Tennessee

April 1971

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TABLE OF CONTENTS

	Page
THE RESEARCH PROJECT: AN OVERVIEW	1-1
Objectives	1-1
Procedures	1-1
Problem	1-1
Questions to be Answered	1-2
Relationship to Other Research	1-3
Procedure	1-3
Summary of Findings	1-4
APPENDIX A	
Form 1 - Schools	2-1
Form 2 - Form Used to Collect Data from High School Records	2-3
Form 3 - Questionnaire	2-5
APPENDIX B	
The Differential Benefits of Vocational Training	3-1
Introduction	3-1
The Data	3-2
Costs	3-3
Benefits	3-4
Results: Rates of Return	3-5
Analysis of Variations	3-6
Conclusion	3-13
APPENDIX C	
Income Differences Among Vocational Trainees: A Procedure for Internal Comparisons with Selected Findings	4-1
Study Population and Data Collection	4-2
Analysis	4-3
Summary	4-21
APPENDIX D	
The Effect of Vocational Training on the Income Education Distribution	5-1
Introduction	5-1
The Data	5-2
Analysis	5-7
Conclusion	5-17

LIST OF TABLES

Number		Page
	APPENDIX B	
I	Internal Rates of Return	3-7
II	Rates of Return for Selected Groups	3-10
	APPENDIX C	
1	Factor Levels and Number of Observations	4-5
2	Male Instructional Programs	4-7
3	Female Instructional Programs	4-9
4	Sex	4-10
5	Urban-Rural Residence	4-11
6	Race	4-12
7	Relatedness of Training to Occupation	4-13
8	Occupational Mobility	4-15
9	Post-AVTS Training	4-16
10	Geographic Mobility	4-17
11	Marital Status	4-18
12	Level of Educational Attainment	4-19
13	IQ	4-20
14	Age in 1968	4-22
15	Hours of Instruction	4-23
	APPENDIX D	
1	Mean Annual Earning Potential of AVTS Trained Males by Age and Education	5-4
2	Estimated Income for Males in 1968 by Age and Education	5-5
3	Estimated Income for Males in 1968 by Age and Education as a Percent of Income of High School Graduates	5-10
4	Mean Earnings Potential of Male AVTS Trained Public School Dropouts as a Percent of AVTS Trained High School Graduates	5-12
5	Earning Potential of AVTS Males by Age and Education as a Percent of 1968 Income Estimates by Age and Education	5-14

LIST OF FIGURES

Number		Page
1	Relationship of Educational Attainment to Income in Nation and Earnings Potential to Educational Attainment in AVTS Sample.....	5-8
2	Relationship of Educational Attainment to Income and Earnings Potential as Percent of High School Graduate Income and Earnings Potential in Nation and in AVTS Sample.....	5-9
3	Education-Income Distribution of AVTS Sample as Percent of Education-Income Distribution of National Population.....	5-15

THE RESEARCH PROJECT: AN OVERVIEW

1. Objectives

The objectives of the study were to answer the following three questions: (1) How do the characteristics of students and their training affect the rate of return to investment in vocational training? (2) How do these characteristics affect the earnings of trainees? and (3) How does vocational training influence the distribution of income among educational groups? The student characteristics analyzed included sex, rural or urban residence, race, I.Q., marital status, age, relatedness of occupation to training, and formal schooling. The training characteristics included type and length of training.

2. Procedures

The data examined were collected in an earlier study. They consisted of detailed records for 127 vocationally trained subjects and 127 individually matched cohorts. In the analysis of earnings, records for 411 vocationally trained subjects were available. Analysis of covariance was employed to estimate the specific effect of each individual factor upon the criterion (internal rate of return or earnings). Multiple regression analysis was used to test differences in the measured education-earnings curve of vocationally trained subjects and the comparable curve for the civilian labor force.

3. Problem

Vocational educators have competing goals. One is the narrow economic end of using scarce resources in such a way as to maximize the national product. Others include such broad social goals as equality. The goals are liable to conflict at two points: selection and recruitment of students and decisions concerning the types of programs to be offered. Economic considerations may dictate the selection of the "best" students in terms of socio-economic status and formal education, while egalitarian considerations call for selection of the disadvantaged. Economic criteria may call for the selection of a training program to meet the needs of an expanding industry in a prosperous area, while there are egalitarian reasons for supporting a retrograde industry in a blighted area.

Vocational education programs must compromise these objectives, and information about the differential benefits from vocational training will be useful to planners in making this compromise. Whether benefits are higher for men or women, for long or short programs, or for typists or draftsmen cannot tell us who to train or what to teach him, but it is an important piece of information, and better decisions are likely to be made when more information is available.

4. Questions to be Answered

(a) How do the characteristics of the trainee and the characteristics of his training affect the rate of return to investment in vocational training? Among the vocational school graduates for whom detailed characteristics are known, we can observe a gain of $590,223 in increased projected lifetime earnings attributable to vocational training, and a loss of $1,109,214 for another individual in the group of graduates. For groups of students less influenced by individual cases, there are rates of return as high as 20.7 percent for students with I.Q.'s of 90 or less and negative returns for students with I.Q.'s of 111 or more. Since the high I.Q. students differ from the low I.Q. students in sex, type, and length of vocational training, urban or rural residence, and many other characteristics, it is necessary to use fairly sophisticated statistical techniques to isolate the influence of each factor. In addition to the characteristics already mentioned, it will be possible to answer question (a) in terms of race, marital status, and relatedness of present occupation to type of vocational training received.

(b) How do the characteristics of the trainee and his training affect his earnings? This question differs from the first, for the influence of each variable upon earnings will not be influenced by any cost factors. We might presume, for example, that high opportunity costs are responsible for the negative returns to students with high I.Q.'s, and that vocational training has a positive influence upon earnings even though it leads to negative returns on invested capital. The selection of income as the dependent variable also makes it possible to add two new characteristics to the list of independent variables, age and level of formal education. (Differential rates of return cannot be explained for these characteristics, since they were calculated for a group of matched pairs with the same age and formal schooling.)

(c) How do vocational training and formal education interact in determining the distribution of earnings? If education leads to increased earnings, there are a number of possible effects of superimposing vocational training upon a population with varying degrees of formal schooling. The vocational training might equalize earnings, so that the highly educated lose all or most of their advantage, or it might benefit the educated student more than the dropout so that his relative income advantage becomes even greater. In geometric terms, we can put the question this way: A graph of education and earnings for a population without vocational training will produce a positively sloped curve. If each member of the population is now given beneficial vocational training, does the curve become steeper, flatter, or negative, or does it simply shift to a higher level parallel to the original curve? This seems the most original of our questions, for we cannot find an attempt to answer it empirically in the existing literature.

5. Relationship to Other Research

Many empirical studies have attempted to measure the benefits of investment in vocational training.[1] These studies have not often tried to isolate factors related to high and low rates of return. Borus and others found that males, high-school dropouts, and those remaining longest in the program had the highest earnings gain from NYC training.[2] Rasmussen found that rates of return for OJT varied geographically, from zero in Portland, Oregon, to 167.4 percent in Miami.[3]

Hardin has noted that failures to consider trainee characteristics, different labor markets, and various kinds and durations of training programs constitute a common flaw in many existing studies.[4] The present study is a step toward remedy of this shortcoming.

As noted earlier, there is almost no hard evidence of the influence of vocational training on the established distribution of income by educational levels. This question has a substantial literature of its own, with the works of Herman Miller among its best-known members, and it is hoped that the proposed research will make some contribution to knowledge in this area.[5]

6. Procedure

(a) Research method. Survey involving comparison of experimental and control groups.

(b) Study subjects. The study population included 411 questionnaire respondents among a random sample of students who attended Tennessee Area Vocational-Technical Schools before 1968 and had potential civilian labor force experience in 1968.[6] The sample included substantial numbers of males and females, whites and Negroes, and rural and urban residents. Educational attainments ranged from one year of elementary school to four years of college, and measured I.Q.'s and high school grade point averages had a wide range. The occupational training periods at AVTS ranged from 3 months to 3 years, and the vocational courses pursued were health occupations, office occupations, drafting, mechanics and repairmen, cosmetology, machine shop, and welding.

In addition to the 411 vocationally-trained subjects we had information concerning 127 untrained high-school graduates individually matched in a number of characteristics with certain of the trained subjects who were high school graduates, and were drawn from the same high school classes.[7]

There was good reason to believe that the Tennessee Area Vocational-Technical Schools were quite similar to their counterparts in other states, since they were so new and all the schools were created by the same Federal enabling legislation. The range of characteristics in the study population was so wide that generalization to the entire group of non-collegiate high-school graduates appears to have face validity.

(c) Data Analyzed. Between June 1, 1968, and January 31, 1970, the principal investigators conducted a cost-benefit study of training at Tennessee State Area Vocational-Technical Schools, sponsored by the University of Tennessee and the Tennessee State Division of Vocational-Technical Education. The data collected in that study were the basis for analysis in this study.

The authors visited each of Tennessee's 19 Area Vocational-Technical Schools (AVTS) and drew a 25 percent random sample of all former students. Information from school records was obtained on Form 1 shown in Appendix A for 1,701 former AVTS students. We attempted to form 334 matched pairs by selecting the high-school graduates for whom the prospects of finding a match and work experience seemed best. The staff visited the high schools of graduation, and collected further information about the AVTS graduate and his classmates on Form 2 shown in Appendix A. Further information was collected from the ex-AVTS students and their high-school classmates by a mailed questionnaire, Form 3 in Appendix A, for which an overall response rate of 70 percent obtained with a somewhat higher response rate for the AVTS students. In addition to the questionnaire information, individual social security authorizations were received, and we obtained an earnings record for each subject from the Social Security Administration.

The usable data available for analysis under Office of Education sponsorship included reasonably complete information for 411 former AVTS students and 127 well-matched[8] pairs of trained and untrained graduates of the same high school class. We believe that these data were adequate to realize the objectives of the proposed study.

7. Summary of Findings[9]

(a)[10] An internal rate of return was computed for a sample of 127 former area vocational-technical school (AVTS) students. Costs and benefits were obtained by matching each sample member with a cohort and determining their labor force experiences from responses to questionnaires and examination of social security earnings records.

The method of data collection, cohort matching procedure, and the computation of the rate of return should be useful to those contemplating similar investigations, but the most important aspect of the study involves a disaggregation of the rate of return by various student and program characteristics. An overall rate of return of 6.3 percent was found. Analysis of covariance with Scheffe's significance test allowed the authors to examine the differential benefits. One of the stronger and more pronounced relationships uncovered through use of this technique was the negative association between I.Q. and benefits from vocational training. The category of former students with measured I.Q.'s of 90 and less earned the highest rate of return of all disaggregated groupings (29.1 percent as compared to 5.9 percent for I.Q.'s of 91 to 110, and a negative return to I.Q.'s of 111 and over).

(b)[11] An internal comparison procedure was developed to analyze the effects of various student-related and program-related characteristics on the potential income of former post-high school vocational students.

The advantage of the methodology lies in its accuracy as a "follow-up" device for various training and educational programs. The methodology includes the use of a controlled and well-conceptualized method of data collection, use of potential income (rather than income) that offers some control on unemployment and participation rates, and a statistical design (analysis of covariance) that allows estimation of the effects of a specific variable independently of covariate influence.

The following conditions among former vocational students were found to be related to relatively higher potential income: study in health occupations (among females); being of the male sex; working at a job that required specific training; migrating to another state; being married; being a high school graduate; receipt of only three to seven months of full-time vocational training (as opposed to greater amounts).

(c)[12] Whether or not vocational training administered to an educationally diverse group will increase the potential income of grade school graduates, high school dropouts, and high school graduates by a constant sum or in ratio to their expected earnings in the absence of vocational training is an important policy question. The propositions were tested to see which most accurately described the labor force experience of an educationally heterogeneous group of former students in the Tennessee Area Vocational-Technical School system. The latter proposition remained intact after two rigorous statistical tests. The slope of the income-education curve was not altered by the administration of vocational training, although there is strong evidence that there was an upward shift of the curve.

From a policy standpoint, there is no reason to question this type of training as an anti-poverty device so long as poverty is conceptualized as income below an absolute level. Training led to similar proportionate income gains among the educationally deprived as well as the high school graduates. However, the data and analysis do not evidence income redistribution from the educated to the uneducated as a result of vocational training.

FOOTNOTES

[1]See, for example, Michael Borus, The Economic Effectiveness of Retraining the Unemployed, Ph.D. dissertation, Yale, 1964; M. Borus, "Time Trends in the Benefits from Retraining in Connecticut," Proceedings of the Industrial Relations Research Association Meetings, December 1967; Arthur J. Corazzini, Vocational Education, A Study of Benefits and Costs, U. S. Office of Education, 1966; Adger Carroll and Loren Ihnen, Costs and Returns for Investments in Technical Schooling, North Carolina State University, 1967; Max Eniger, The Process and Product of Vocational Education, Pittsburgh, 1965; J. J. Kaufman, E. W. Stromsdorfer, et al., An Analysis of Comparative Costs and Benefits of Vocational and Academic Education, Pennsylvania State University, 1967; Earl Man, "A Nation-wide Evaluation of MCIA Job Training," Journal of Human Resources, Spring 1968; D. A. Page, "Retraining Under the MDIA: A Cost-Benefit Analysis," Public Policy, 1964; G. G. Somers and E. W. Stromsdorfer, "Benefit-Cost Analysis of Manpower Retraining," Proceedings of the Industrial Relations Research Association Meetings, 1964; Michael Taussig, An Economic Analysis of Vocational Education in New York City High Schools, Brookings Institution, 1967; Daniel C. Rogers, Private Rates of Return to Education in the United States, Ph.D. dissertation, Yale University, 1967; and Dale B. Rasmussen, Determinants of Rates of Return to Investment in On-the-Job Training, Ph.D. dissertation, Southern Methodist University, 1968.

[2]Michael E. Borus et al., "A Benefit-Cost Analysis of the Neighborhood Youth Corps," Journal of Human Resources, Spring 1970.

[3]Rasmussen, cited in note 1.

[4]Einer Hardin, "Benefit-Cost Analysis of Occupational Training Programs: A Comparison of Recent Studies," North American Conference Proceedings, Wisconsin, 1969.

[5]Representative of these works is Herman P. Miller, "Annual and Lifetime Income in Relation to Education," American Economic Review, December 1960.

[6]For a more complete description of the population and the process of drawing the sample, see R. L. Bowlby and W. R. Schriver, "Nonwage Benefits of Vocational Training," Industrial and Labor Relations Review, July 1970.

[7]See Bowlby and Schriver, op.cit., for a more detailed description of the matching process.

[8]The pairs are similar in all the characteristics listed in Appendix B. For a more complete description of the study design, see Bowlby and Schriver, op. cit.

[9]Each of the three questions raised in the beginning of this report is examined separately in the three following manuscripts included as Appendices B, C, and D. The summary is taken from these detailed works.

[10]See Appendix B.

[11]See Appendix C.

[12]See Appendix D.

APPENDIX A

Form 1

SCHOOLS

1. Name of School _____

2. Name _____
(Last Name) (First Name) (Middle Name)

3. Address (Last Known) _____
(Street)

_____
(City) (State)

4. Age _____

5. Sex _____

6. Marital Status _____

7. Date of Birth _____
(Month) (Day) (Year)

8. Parent or Guardian _____

9. Address of Parent or Guardian _____

_____

10. Hours of Instruction Received (Total) _____

11. Last Program in Which Enrolled _____

12. GATB Scores:

G ____ V____ H____ S____ P____ Q____ K____ F____ M____

13. Performance in School:

Above Average _____ Average _____ Below Average _____

14. Last Known Mailing Address _____

15. Employer (Last Known) _____

16. Reason for Leaving _____

_____

Form 1 (Continued)

17. Race _____

18. Date of Entry _____

19. Date of Exit _____

20. Last School Attended _____

21. Number of Years Completed _____

22. Telephone Number _____

Form 2

FORM USED TO COLLECT DATA FROM HIGH SCHOOL RECORDS

	Experimental Subject	Control #1	Control #2	Control #3	Control #4	Control #5
Name						
Date of Birth						
Last Known Address						
Address of Parent or Guardian						
Name of Parent or Guardian						
Father's Occupation						
Sex						
Race						
Year of Graduation						
Grade Point Average						
I.Q. Score Test _____						
Rank in Class of _____						
Type of Program (Academic, Vocational or General)						
College Attended (If any)						
Unusual Disciplinary Problems or Extra-curricular Activities						

Form 2 (Continued)

	Experimental Subject	Control #6	Control #7	Control #8	Control #9
Name					
Date of Birth					
Last Known Address					
Address of Parent or Guardian					
Name of Parent or Guardian					
Father's Occupation					
Sex					
Race					
Year of Graduation					
Grade Point Average					
I.Q. Score Test _____					
Rank in Class of _____					
Type of Program (Academic, Vocational or General)					
College Attended (If any)					
Unusual Disciplinary Problems or Extra-curricular Activities					

Form 3

AT THE END OF THIS QUESTIONNAIRE THERE IS SPACE
FOR YOUR COMMENTS AND OPINIONS

1. Name _____
First Last

2. Present Address _____ _____ _____
Street or Route City State

3. Do you now have a job? _____ _____ Are you a Veteran? _____ _____
No Yes No Yes

IF YOU DID NOT HAVE ANY JOB DURING 1968, SKIP QUESTIONS 4 AND 5 AND GO TO QUESTION 6

4. Please answer these questions about your present or most recent job.

a. For whom do you work? _____
(Name of Company, Business or Organization)

b. What kind of business or industry is your employer in? _____
(Such as:

_____
Shoe Factory, Grocery Store, Farm, Paper Mill, Bank, etc.)

c. What kind of work are you doing? _____
(Such as: Welding, Truck Driving

_____
Farming, Bookkeeping, Assembling, Machine Operator, etc.)

d. Are you self-employed? _____ _____ If yes, how much do you
No Yes

earn (after business expenses) on the average per month? $ _____
per mo.

e. If you work for someone else, how much do you earn on the average before any deductions, counting overtime and incentive pay if you get it? $ _____ per _____.
hour, week, or month

f. Were you out of work at any time during 1968? _____ _____ If
No Yes

yes, how many weeks were you out of work? _____ Why? _____
Weeks (Reason)

_____

5. Have you done other kinds of work during 1968, different from your answer to Question 4(c)? _____ No _____ Yes If yes, what other kinds of work have you done? _____

(Such as: Welding, Truck Driver, Selling, Farming, Bookkeeping, Assembling, Machine Operator, etc.)

IF YOU ANSWERED QUESTIONS 4 AND 5, SKIP 6 AND GO TO 7

6. Why were you out of work during 1968? _____

7. What is your present marital status? _____ Married _____ Single _____ Other

IF SINGLE, PLEASE GO TO QUESTION 8. IF MARRIED OR OTHER, PLEASE ANSWER a AND b BELOW

a. In what year were you married? _____ Year

b. If you have children at home, give year of birth of oldest child.

_____ Year

8. Have you ever taken any training or education programs for at least six weeks not counting high school? _____ Yes _____ No

(Such as: college, junior college, technical institute, business college, barber college, apprenticeship, area vocational-technical school, company training, Armed Forces school, correspondence schools, etc.)

Kind of Program	Began (Month & Year)	Ended (Month & Year)

Form 3 (Continued)

COMMENTS AND OPINIONS

(Include whether or not you have been able to find work that suits your abilities and training, or anything else you want to tell us about your answers.)

APPENDIX B

THE DIFFERENTIAL BENEFITS OF VOCATIONAL TRAINING

Introduction

Vocational training involves two different allocation processes. In the first, society must determine the share of its scarce productive capacity to be allocated to vocational training and necessarily denied to all competing claims. If the market solution for this problem is not accepted, which has been the case for more than a hundred years in the United States, public education comes into being and gives rise to the second allocation problem: given limited resources available for devotion to vocational education, who should be trained, and what type of training should they receive?

Benefit-cost analysis and its variants have been widely applied by economists to the first problem. Marginal analysis suggests that expenditures for vocational education should be adjusted until their rate of return reaches some rate not easy to specify representing opportunity costs. The present report makes some contribution to that literature, for it involves a computation of the rate of return to investment in vocational education for a group of young people trained at Tennessee State Area Vocational-Technical Schools. This rate of return has a certain importance in its own right, and the methods used to compute it will be of interest to those conducting empirical research of this sort, while the results can be compared with rates of return computed by others for other sorts of education on other types of populations.

The second problem has been less widely investigated. The benefits of education are in fact a function of at least three variables: the characteristics of the educational program, the characteristics of the students, and the characteristics of the environment into which the students graduate. Most published attempts to investigate the benefits of education have measured the joint effects of all these variables, so that no resolution of the second problem is possible.

The main thesis of the present report is that the same sort of measurements appropriate to the resolution of the first question can also be used in attacking the second. Given limited student enrollments, we could expand or contract enrollment of boys and girls, whites and blacks, welders and typists, etc., in such a way as to maximize the social benefits from training resources if only we could measure the rate of return characterizing each sub-group of the trained population. For the labor force as a whole such a measurement is impossible because of the aggregation of the data. Detailed information for 254 individuals is the basis for the present analysis, which rests upon the assumption that this sample is reasonably typical of non-collegiate high school graduates.

The Data

From June 1968 to January 1970 the authors conducted a research project involving measurement of the rate of return to investment in training at all the 19 Area Vocational-Technical Schools (hereafter AVTS) then active in the State of Tennessee. Each school kept complete records of its former students; a 25% random sample yielded 1,701 former students. In measuring the rate of return, 1,367 of these students were eliminated arbitrarily for the following reasons: (1) left AVTS too late to have labor force experience during all of 1968, (2) did not stay in AVTS for as many as 300 hours of instruction, taken as the minimum necessary for acquisition of marketable skills, (3) did not graduate from a Tennessee high school, (4) left school to enter college or military service, or (5) were born before 1943. The 334 subjects remaining after these exclusions may be regarded as representative of the target population of non-collegiate, civilian Tennessee high school graduates. Since they represent 19 different vocational training schools and more than 200 different high schools, a wide range of labor market conditions and characteristics are represented and it seems not unreasonable to hope that the target population is fairly represented.

The next step was an attempt to form 334 matched pairs by visiting the high school of each AVTS student and finding another member of the same graduating class with characteristics similar to those of the AVTS student. For 243 of the students it was possible to locate a high school classmate with the same race, sex and course of study (academic, vocational or general) and approximately the same age, grade-point average, and I.Q. An attempt to match father's occupation by broad classification failed because the school records were incomplete (and often named employers rather than occupations), but a few potential matches were rejected when it could be established that they involved children of blue-collar and white-collar workers.

A questionnaire was mailed to the 243 remaining students and one or more potential match for each. The questionnaire included a social security authorization form giving us access to earnings records of each student. While the overall response rate was 70 percent for the questionnaires delivered to civilians, only 127 matched pairs resulted, since many of the subjects proved to be in military service, and a matched pair was lost whenever a subject or all his high school classmates failed to respond, served in the military, or moved without leaving a forwarding address.

The 127 matched pairs included 62 males and 65 females; 35 urban and 92 rural students, 114 whites and 13 black students, and a range of I.Q. scores and high school grade averages such that it appears to be reasonably typical of the non-collegiate high school group constituting the target population. The median period of training at AVTS was a little less than a year and the vocational courses pursued can be classified into seven groups: health occupations, office occupations, drafting, mechanics and repairmen, cosmetology, machine shop and welding.

Costs

The cost of training for each student was built up from four components: (1) public capital cost, (2) private capital cost, (3) public operating cost, and (4) opportunity cost. The method for estimating each cost can be discussed in detail.

Public Capital Cost

All the physical facilities occupied by the schools were built between July 1, 1963, and December 31, 1967, with public funds. Land for the schools was donated by the counties in which they are located and is not included as a cost item, but with this exception we were able to measure all of the capital cost. Expenditures at various dates, totalling almost $18 million, were converted to dollars of July 1, 1963, by using a discount rate of 4%, the assumed rate at which the State of Tennessee could have borrowed money during 1963. A useful life of twenty years was assumed for the buildings, so that the 4½ years in question were assigned 9/40 of the total cost. This sum was divided by the number of hours of AVTS training received by all students during the study period to reach a capital cost of 69¢ per hour of instruction. This coefficient was multiplied by the hours of instruction received by each student to yield a personal cost for each individual. All this cost was presumed to be incurred during the quarter of first enrollment. Estimated cost for the 127 students came to $112,246.

Private Capital Cost

Tuition was free during the study period at all schools, but some programs involved costs for books, supplies, uniforms and equipment. In some cases the cost varied from school to school in the same program, but the main variation (from a low of $5.50 to a high of $152.10) was among different types of programs. All this cost was charged to the quarter of first enrollment.

The total for all 127 students was $5,033. No cost was charged for commuting to school, though we have enough cost data to know that it is an important cost item for most students, on the grounds that no deduction for commuting cost was made from the employment used as an opportunity cost, so that the opportunity cost computed here includes the cost of commuting to work, which we assume to equal the cost of commuting to school.

Many of the students incurred negative costs in the form of training allowance, most notably veteran's benefits. These should properly be deducted from private costs and added to public costs. This adjustment was not made because reliable cost figures were not available; while the adjustment would not alter our total rate of return, it would increase the private rate of return and depress the public rate.

Public Operating Costs

These included all maintenance and operations at the local schools. Some administrative expenses in Nashville appear to be missed because of the impossibility of separating out the overhead costs of an organization (the Division of Vocational-Technical Education) that has responsibilities at the secondary level as well as for general supervision of the area schools. This must be a minor item, and may be offset by the fact that school facilities are used without charge by a few civic groups such as boy scout troops to whom it was not feasible to allocate any cost. The total cost was allocated to the students, with division of total costs by total hours of instruction yielding a cost of $1.05 per hour of instruction received. Again we obtained a personal cost for each individual student by multiplying this figure by his hours. This cost was spread evenly over the quarters in which the student was enrolled.

Opportunity Cost

Since we had access to the social security record of each of our 127 students and his match, we measured opportunity costs by subtracting earnings of the high school classmates from the earnings (if any) of the AVTS student for each calendar quarter during which he was enrolled in school. A good number of the AVTS students worked part-time while at school, and a few (to judge by their earnings records) must have been employed virtually full-time. For 15 of the 127 students these costs were negative, and in two cases the negative costs were greater than the total of the three cost items already discussed, so that for a tiny minority of our students, attendance at AVTS (as measured here) was at substantially zero cost. The group of 127 had costs of $173,339, and the range was from $7,750 for one individual to minus $2,862 for another.

Benefits

The benefit computation, like the calculation of opportunity cost, was based on a comparison between the two members of each matched pair, with the benefit defined as the algebraic difference between the earnings of the trained subject and his untrained high school classmate.

Since the earliest students had about five years of actual or potential labor force experience and the latest students had only a year (calendar 1968), there was no single earnings base obviously suitable for all of the paired observations. Some experimentation with alternatives such as average quarter, high quarter and 1968 average produced quite similar results, and the figures here are all based upon high quarter earnings as the basis for measurement of benefits. The logic for using the high quarter for each individual is that it is the best measurement of earnings potential, and that vocational training can more reasonably be hypothesized to increase earnings potential than to increase actual earnings. The figure so derived has the characteristic of minimizing the influence

of unemployment, part-time work, and non-participation in the labor force, so that the rate of return computed here will tend to measure the primary influence of training upon earnings via skill formation and neglect the secondary influences that may influence income through those variables.

The high quarter earnings, whenever they occurred, were attributed to the quarter following departure from AVTS, and the high quarter earnings of his matched cohort, whenever they occurred, were attributed to this same quarter. This gross earnings difference was the basis for the benefit computation; it was positive in 80 cases and negative in 47. Earnings growth was assumed for both members of the pair at the rate of one percent per quarter (approximately the long-run gain in productivity for the economy as a whole) until age 35, and stable earnings were assumed thereafter until age 70 (for men) or 60 (for women). Finally, joint probabilities of survival and labor force participation were computed at each age group for each sex, and these probabilities were multiplied by each computed benefit to discount the probabilities of death or non-participation.

These assumptions produced a wide range of lifetime benefits. The largest gain was recorded by an AVTS student with high quarter earnings of $2,942, or $226 per week, by comparison with earnings of $1,521 in his own best quarter by the untrained cohort. This student has potential benefits of $590,223 during his working life according to the stated assumptions. At the other extreme was a student with $875 of high quarter income compared to $3,884 (the highest earnings figure in our study population) by his untrained high school classmate. Our assumptions applied to this case indicate a potential lifetime loss of $1,109,214 attributable to school attendance.

A wide variety of benefit assumptions concerning the projected experiences of these relatively young people over their lifetimes could, of course, be made, and each new assumption would produce a different rate of return. The particular assumptions made here can be defended as being reasonable, if not as "correct" or "exact" in any sense, and even substantial departures from these assumptions, though they would significantly raise or lower the computed rate of return, would probably not change the relationships among the rates of return for such sub-groups as males and females or welders and draftsmen as long as they are based on the same earnings difference, positive or negative, between each AVTS graduate and his high school classmate of equal ability.

Results: Rates of Return

Given a set of cost and benefit figures, the internal rate of return can be defined as the unique rate that makes the present value of benefits exactly equal to the present value of costs. Since each benefit and each cost can be identified with a particular calendar quarter, mathematic expression of the rate of return will be simplified by numbering the 285 quarters from the third quarter of 1963 (the first quarter in which any costs were incurred) through the third quarter of 2034 (the last quarter in which any of the 127 subjects can possibly be on the sunny side of 70),

consecutively. The rate can then be expressed as the value of r which solves the equation

$$\sum \frac{C_1(i) + C_2(i) + C_3(i) + C_4(i)}{(1 + r)^i} = \sum \frac{B(i)}{(1 + r)^i}$$

where C_1, C_2, C_3, and C_4 are the four cost items identified earlier, B is the benefit figure, and each i is a calendar quarter, so that r is the only unknown. A modified rate including only the two latter cost figures (and consequently always higher) can be identified as the private rate of return, though as noted earlier, there are some characteristics of the data that make the total rate of return more reliable than the private one. A rate of return to the government is not calculable, for there is no measurement for governmental benefits. No doubt such governmental benefits as higher tax collections (which of course lower private benefits dollar for dollar) and lower rates of incarceration, unemployment, and welfare costs (which lead to increased private benefits) take place, and no doubt the multiplier effect of higher incomes for the trained population diffuse benefits throughout the economy, so that the rates of return computed here may be judged as conservative. Again, it seems probable that different assumptions would produce a higher rate of return but would have little influence upon the differential rates of return that are the primary concern of this report.

Table I shows the internal rates of return, total and private, for the 127 matched pairs and some of the more important sub-groups of the population. It indicates an overall rate of 6.3 percent for the 127 matched pairs, with higher rates for females, workers who moved following training and worked in jobs related to their training, rural youth, whites, students with low I.Q.'s, and students with occupational specialties in welding, mechanics, machine shop and office occupations.

Analysis of Variations

While there is a sense in which the data in Table I answer the questions posed initially, there is another sense in which they raise as many questions as they answer, for they do not show interaction among the variables. The high rate of return for students with low I.Q. and the low rates for high I.Q. students, to take a more or less random example, might be caused entirely by a concentration of low I.Q. students in the machine shop program and high I.Q. in drafting. I.Q. as such could conceivably have nothing to do with the rate of return; the argument could be inverted to show that the computed rates are consistent with a situation in which the type of program has nothing to do with rates of return, but I.Q. is all important. By extension, it is also possible that neither I.Q. nor types of program are really important, but that yet another factor (perhaps hours of instruction in AVTS) determines the differential benefits of vocational training.

Table I

INTERNAL RATES OF RETURN

Number of Pairs		Percent Rate of Return	
		Total	Private
127	All subjects	6.3	13.4
62	Males	2.3	5.9
65	Females	10.0	26.5
109	Without geographic mobility[1]	3.2	7.1
18	Geographically mobile[2]	19.5	--[a]
35	Urban	--[b]	--[b]
92	Rural	8.6	16.5
114	White	6.9	14.3
13	Negro	--[c]	1.3
20	Low (90 or less) I.Q.	29.1	73.6
65	Medium (91-110) I.Q.	5.9	12.0
23	High (111 and over) I.Q.	--[b]	--[b]
82	Placed in jobs related to training	8.5	16.1
42	In unrelated jobs	--[b]	--[b]
17	Drafting students	--[b]	--[b]
11	Welding students	9.0	--[b]
22	Mechanics and repairmen	10.7	20.0
11	Machine shop students	14.7	27.2
20	Health occupations	0.8	4.3
46	Office occupations	11.2	27.7

[1] Still lived in county of high school graduation or adjacent county.

[2] Moved more than one county away from county containing high school of graduation.

[a] More than 308 percent (too high to compute).

[b] Negative benefits (no return calculable).

[c] Positive benefits, but less than costs (no return calculable).

The analysis of covariance is an appropriate statistical technique for the resolution of these conflicting claims. In principle this analysis permits us to hold all other things (covariates) constant, and consider the cause and effect relationship between a cause (factor) and a result (criterion). In terms of the preceeding discussion, we need to select a criterion for judgment (the rate of return on costs), select a hypothetical causal agent, or factor (I.Q.) influencing the criterion, and measure the relationship between the factor and criterion while holding the covariates (type of program and hours of instruction) constant. As soon as this analysis is completed, we could select type of program as the factor and I.Q. and hours of instruction as covariates and complete our analysis of variance by selecting hours of instruction as the factor and I.Q. and type of program as the covariates. If the true causative agent(s) have been captured in our data, this process will ultimately make it possible to identify them.

The Criteria

For the group of 127 matched pairs, the appropriate criterion, or result to be explained, is the rate of return shown in Table I. Since each of the 127 pairs embodies a different combination of factors and covariates, it is necessary to measure the level of the criterion variable in each of the 127 observations. No rate of return can be computed for the 40 individuals who failed to experience any returns, and the rate computation is impossible even for some of the population sub-groups shown in Table I.

Since a rate of return cannot be computed for each paired student, it is necessary to select a proxy variable that measures as closely as possible the contribution of each individual to the rate of return for the group. The first proxy, which can be designated as the gross income difference, is simply the algebraic difference between the high quarter earnings of the AVTS student and those of his untrained schoolmate. As noted earlier, this figure has a range from $1,421 to minus $3,009.

The gross income difference is logically objectionable as a proxy variable because it is not influenced by the cost of training. A second proxy, which can be designated as the net income difference, is derived by multiplying the gross difference by 45.5 and subtracting total costs. The constant multiplier is selected because the mean student required 45.5 calendar quarters of higher income in order to recoup the total cost, public and private, of his education. It can be added as a matter of interest that the mean student required 17.7 quarters to recover his personal costs as they are measured here.

These criteria represent an approximation of the contribution of each matched pair, and as will be seen shortly, the choice between them is of comparatively little concern as they are explained by essentially the same factors. The first criterion has the virtue of being easy to understand and interpret, while the second measure has the incidental advantage

of a zero mean so that above-average or below-average figures can be easily determined by inspection of the sign.

The Factors and Covariates

Data are available to examine 12 variables as possible causative agents explaining the level of the criterion measure. Each, in turn, can be permitted to vary as a factor while the others are held constant as covariates through the statistical technique of analysis of covariance. Table II exhibits the factors and shows the levels of the two criteria both raw and adjusted for covariation.

Type of program is shown as the first factor. The adjustment for covariation produces a number of changes in the rankings, but none of the differences, notably the difference between drafting and machine shop which amounts to more than $22 per week, can be determined to be statistically significant at the five percent level perhaps because of the small number of observations and the high standard deviation of the groups.

Sex appears as the second factor, and it is notable that the substantial sex differential appearing in the raw data and in Table I is almost completely removed by the adjustment process. This must be interpreted as an indication that the high differential benefits for females are apparent and not real, and that they are explained by factors other than sex.

Place of residence is determined by the high school attended by the pair. This variable fails to produce any statistically significant results, though it does produce a rather striking reversal of ranks. The same holds true for racial differences.

The first statistically significant findings come when the fifth variable, relatedness, is selected as the factor. The classification is based upon a comparison between the occupation listed by the AVTS student at the time he completed the questionnaire and his occupational goal as listed in school records; it is not influenced by the occupation of the untrained cohort. The conclusion that placement in a related occupation leads to a higher rate of return is not unexpected.

Occupational mobility is defined in terms of job changes by the AVTS student, and is not influenced by the occupational mobility of the cohort. Differences among the three mobility groupings are not significant.

A number of the AVTS students had received other post secondary education in addition to AVTS. Like relatedness and mobility, the classification of pairs into the six groups exhibited in Table II was made on the basis of training received by the AVTS students without regard to the training experiences of the cohorts. "Long" and "short" are separated by 300 hours or three months of instruction, the same minimum requirement set for AVTS attendance. Two of the comparisons here are significant at the five percent confidence level.

Table II

RATES OF RETURN FOR SELECTED GROUPS, WITH ADJUSTMENTS FOR COVARIATES

Basis for Group Classification and Number in Group		Gross Returns (Dollars Per Quarter)		Net Returns (Dollars Per 45.5 Quarters)	
		Unadjusted	Adjusted	Unadjusted	Adjusted
Classification by Type of Program					
17	Drafting Students	-$131	-$ 35	-$10,687	-$ 5,978
11	Welding Students	33	92	- 1,164	1,315
46	Office Occupations	123	35	3,244	- 1,691
22	Mechanics and Repairmen	99	176	509	3,838
11	Machine Shop	200	260	3,790	7,796
20	Health Occupations	97	68	- 383	- 261
Classification by Sex					
62	Males	16	88	- 3,423	- 6
65	Females	140	71	3,265	6
Classification by Residence					
35	Urban	85	96	- 64	1,334
92	Rural	77	73	24	- 508
Classification by Race					
114	Whites	77	81	- 143	43
13	Negroes	103	71	1,250	- 377
Classification by Relatedness of AVTS Training to Current Occupation					
72	Same Occupation Trained For	153	179[H]	2,824	4,269[H]
9	Occupation Related to Training	0	- 99[L]	- 4,044	- 8,650[L]
13	Unrelated Occupation	289	212	10,529	6,561
33	No Training Required	- 142	- 141[L]	9,208	- 9,541[L]

(Continued)

Table II (Continued)

Basis for Group Classification and Number in Group		Gross Returns (Dollars Per Quarter) Unadjusted	Gross Returns (Dollars Per Quarter) Adjusted	Net Returns (Dollars Per 45.5 Quarters) Unadjusted	Net Returns (Dollars Per 45.5 Quarters) Adjusted
Classification by Occupational Mobility					
84	No Changes	$ 61	$ 57	-$ 1,096	-$ 1,097
16	Change to Another Occupation in Same Group	156	134	4,367	2,565
27	Change to Different Group, e.g., Semi-Skilled to Skilled	91	118	820	1,893
Classification by Receipt of Training in Addition to AVTS					
98	No Additional Training	52	51[L]	- 1,239	- 1,418[L]
7	Short, Unrelated Training	- 118	- 91	- 9,178	- 7,057
11	Short, Related Training	320	308[H]	11,580	10,901[H]
5	One Year or More of College	- 11	- 34	- 5,114	- 5,456
1	Long, Unrelated Training	66	5	- 899	- 3,695
5	Long, Related Training	467	505[H]	16,945	19,881[H]
Classification by Geographic Mobility					
109	No Mobility	65	72	- 599	- 310
8	Mobility Within Tennessee	18	39	- 3,977	- 1,965
10	Interstate Mobility	283	190	9,710	4,947
Classification by Marital Status					
81	Married	134	122	2,657	2,102[H]
46	Other Marital Status	- 16	5	- 4,679	- 3,702[L]
Classification by I.Q. Score					
21	Less Than 91	282	323[H]	9,196	10,993[H]
82	91-110	50	64[L]	- 1,532	- 572[L]
24	111 and Over	5	- 81[L]	- 2,813	- 7,665[L]

(Continued)

Table II (Continued)

Basis for Group Classification and Number in Group		Gross Returns (Dollars Per Quarter) Unadjusted	Gross Returns (Dollars Per Quarter) Adjusted	Net Returns (Dollars Per 45.5 Quarters) Unadjusted	Net Returns (Dollars Per 45.5 Quarters) Adjusted
Classification by Age					
29	Born After 1948	$ 77	$ 67	$ 671	-$ 701
98	Born 1948 or Earlier	80	83	- 199	207
Classification by Hours of AVTS Instruction Received					
33	300-699 Hours	124	159[H]	4,310	5,810[H]
30	700-1,099 Hours	103	182[H]	1,990	5,626[H]
21	1,100-1,499 Hours	179	193	4,433	5,190[H]
9	1,500-1,899 Hours	- 272	- 242[L]	- 18,047	- 16,316[L]
34	1,900 Hours and Over	48	- 73[L]	- 3,899	- 9,490[L]

H - Significantly higher (at the 5% confidence interval) than the group marked L in the same classification.

L - Significantly lower (at the 5% confidence interval) than the group marked H in the same classification.

Geographic mobility (with the movement of the AVTS student, as usual, controlling the classification of the pair) affords another interesting case of the limitations of computations of the sort shown in Table I, for the adjustment for covariation narrows the spread between movers so that it can no longer be demonstrated as statistically significant. Again the difference is considerable in dollar terms, and it seems likely that only a higher number of movers would be required to demonstrate statistical significance.

The difference between marital status remains substantially unchanged by the statistical adjustment, and is statistically significant. Much the same analysis can be made of the I.Q. classification, the statistical adjustments only serve to confirm the cruder rates of return computed without adjustments, and reported in Table I. Differences between the two age groups seem unimportant, either with or without adjustments.

The last classification pinpoints the hours of instruction received at the AVTS as a factor. It shows significantly higher rates of return for the short-term school attender. This result is less surprising if the nature of instruction at the schools is understood. All teaching is individualized, and the student is encouraged to learn at his own speed and leave as soon as he becomes employable. It follows that the most highly motivated and capable students are found among the short-term attenders.

Conclusion

The feasibility of calculating differential rates of return has been demonstrated by this report, and a number of differentials have been calculated with considerable statistical rigor. While many of the figures could be the subject of diverse interpretations, and further data collection might be considered prerequisite to firm conclusions, the information presented here is worth consideration by policy makers, and it seems likely that it could be used to increase the rate of return flowing from a given volume of dollar expenditures.

APPENDIX C

INCOME DIFFERENCES AMONG VOCATIONAL TRAINEES: A PROCEDURE FOR INTERNAL COMPARISONS WITH SELECTED FINDINGS

The economics of vocational education have received widespread attention from economists, educators, and manpower planners during the past decade. Among economists, this renewed interest in the economics of education can be dated by the now classic work of T. W. Schultz.[1] The principal research efforts of economists in this area have been the computation of benefit-cost ratios and rates of return for investments in education.[2] These studies have been extremely useful in the evaluation of social and private benefits of vocational training, but they have usually failed to provide information directly translatable into curriculum planning, student selection, or other day-to-day educational problems. If economic studies of vocational education are to be useful in the efficient allocation of resources among curricula, categories of students and types of programs, then future studies must go beyond the mere justification of broad educational systems.

Too often, the economic studies have not isolated the effects of specific curricula on benefits nor the relationship of various student characteristics to benefits. Although Rasmussen[3] found that benefits of vocational education vary with city size and industrial mix and Borus[4] found that male high school dropouts received relatively greater benefits from post high school vocational education than females or high school graduates, little else in the economics of education has been reported that demonstrates contrasts in benefits.

Another criticism of these economic studies, in terms of failure to provide specific program and curriculum guidelines, centers on the concept of "benefit." Benefits are the excess of expected lifetime income streams over cost streams usually discounted to present value at some arbitrary rate. Not only are capital and operating costs considered but trainee opportunity costs as well. It is difficult to determine what a trainee would have earned while undergoing training or what he would have earned without training. The economist is frequently forced to rely upon estimation by aggregation and disaggregation of published statistical data or poorly matched control groups that frequently amount to little more than crude measurement of training effects. Then too, assumptions concerning discount rates and expected lifetime income streams may override the direct effects of education.

If economic evaluation of vocational education has tended to be too abstract and general, evaluation by educators may be even more deficient. Sharp and Krasnegor[5] in their survey of follow-up studies of vocational education point out that the validity of follow-up methods is dependent upon appropriate and random samples, control of non-response bias, and the application of appropriate statistical and analytical techniques. Most of the studies summarized by them appeared to be of but limited value to educational planning. Not only are sample design and response bias open to serious question in many cases, but the variables

used to evaluate the programs and their measurement are subject to great difficulties in interpretation. Frequently, former students were asked to evaluate their training, their attitude toward jobs, or to describe their post-training labor force experience.

Warmbrod[6] summarized the problem by stating, "Research conducted by vocational educators relating. . .to the economic value of vocational-technical education has been primarily descriptive rather than analytical. Research conducted by economists. . .has been limited in scope and concept, particularly in the identification amd measurement of the benefits of vocational-technical education."

In 1968 the authors undertook an investigation of the rate of return to a statewide system of vocational-technical schools. In addition to this more general analysis, an attempt was made to develop a follow-up procedure and an analytic technique that would allow specific program evaluation. Data obtained in that study are the basis for this article.

Study Population and Data Collection

From files containing the records of all former Tennessee Area Vocational-Technical School (AVTS) students, a one-in-four random sample of 1,701 subjects was drawn.[7] Rejecting students for the following reasons led to a reduced sample of 587: (a) less than three months AVTS attendance; (b) recorded physical, behavioral, or psychological disabilities; (c) left AVTS to join armed forces or attend college; and (d) left AVTS later than December 31, 1967. Biographic data and training data were obtained from AVTS records. Each former student was then sent a questionnaire in February 1969 requesting detailed labor force experience in 1968 and authorization for the release of their Social Security income account.[8] Each questionnaire was accompanied by fifty cents as payment for service rendered. A 70 percent response rate was obtained, resulting in a net sample of 411. A test of differences between respondents and nonrespondents revealed no significant differences, except under-representation of males (and male-related programs) due to a high rate of military service and consequent disqualification. This bias is statistically removed by controlling on sex.

Rather than relying upon income reported by the respondent, measurement was improved by contracting with the Social Security Administration to provide quarterly income account records for sample members on the basis of signed authorization cards.[9] It is a well known phenomenon that individuals respond unpredictably to questions about income even when the questions are clear as to types of income and method of computation.

Social Security records offer an advantage in that all persons in covered employment (98 percent of the net sample) are required by law to pay a tax on a fixed earnings base, and as long as the individual earns less than the base, his earned income by quarter is directly obtainable from Social Security records. For a few subjects, annual income exceeded the wage base, and covered earnings could be determined with complete

accuracy only for the first two or three calendar quarters of the year. Earnings estimates for members in uncovered employment (approximately 2 percent), such as railroads and certain federal and state employment, were made from responses to wage rate items included in the questionnaire when the responses were clear and unambiguous.

For this study "potential earned income" (hereinafter income) was computed by selecting for each subject the quarter of highest earnings between departure from AVTS and the last quarter of 1968 inclusive. (The earliest AVTS departure date was in 1963, but all members had at least four potential quarters of civilian labor force experience.) This can reasonably be taken as an index of a worker's earning capacity, and quarters of lower earnings can be rejected on the assumption that the worker was below capacity. This assumption will tend to eliminate income distortions due to low participation, unemployment, child bearing, labor disputes, illness, accidents, etc.[10] Logical support for this approach rests in the idea that vocational education increases the individual's earning capacity, and this potential is a more legitimate measure of the income effect of education than actual earnings during a limited time interval.[11]

Analysis

The purpose of the analysis presented here is to distinguish among levels of income associated with specific student and training program characteristics. However, it is not satisfactory merely to compare the income of certain categories of vocationally trained workers with others, for observed income differences could be attributable to the interaction of other and uncontrolled variables. For example, if it were found that students trained in machine shop earned on the average $3,000 more annually than did students trained in health occupations, the income difference could be attributable to compositional differences with respect to sex, IQ, hours of instruction, or level of prior educational attainment. In order to remove this source of error, a more sophisticated statistical model must be employed.

An analysis of covariance model was selected that allows computation and removal of the interaction effects of covariates and provides estimates of the adjusted treatment means of the criterion at predetermined levels of a single factor.[12] Using the example above, income is the criterion; sex, IQ, hours of instruction, and level of prior educational attainment are covariates; machine shop and health occupations are the two levels (treatments) of the factor "type of program." The effect of the computations specified in the analysis of covariance model is to hold all the covariates constant and estimate the mean of the criterion for each level (treatment) of the factor. If the $3,000 difference remains after these adjustments, it represents a true contrast between machine shop and health occupations. If it disappears as a result of the computations, the observed difference is spurious and results from differences in the covariates, not in the type of program. Although unadjusted factor means are also shown in the subsequent tables, the adjusted treatment mean estimates are used exclusively in the analysis. Statistical significance was estimated by Scheffé's test.[13]

For each of the 411 students data were recorded, in addition to the income criterion, on the following variables: (1) instructional program, (2) hours of instruction, (3) sex, (4) level of prior educational attainment, (5) age, (6) IQ, (7) race, (8) relatedness of instructional area to present occupation, (9) post-AVTS training or education, (10) geographic mobility, (11) occupational mobility, (12) rural-urban residence, and (13) marital status. The model treated each of the above variables separately as factors with the remaining twelve variables entered into the equations as covariates. Table 1 shows the various levels into which the fourteen factors were subdivided.

A caveat must be stated concerning the legitimate inferences that may be drawn from the analyses subsequently presented. The reader is cautioned not to infer cause-effect relationships between vocational training and any of the variables analyzed. Although the authors have attempted to do so in another paper, suffice here to say that one is limited to the inferences that compare income experiences of categories of trainees against other categories of trainees.[14] Since this model does not compare the vocationally trained against a similar non-trained control group, cause-effect relationships cannot be examined.

The usefulness of the internal comparison procedure and findings presented here lies in their rather straightforward estimation of average potential income rates attained by former students described by the variable under consideration. These income ranks (adjusted mean income) may be used to evaluate certain student and program characteristics as *they relate to income potential.* Thus, it is the relative ordinal (and interval) rank of a specific treatment level in the criterion hierarchy within a category that estimates how students possessing that attribute (the specific treatment) fared in the labor force. This technique allows program planners to evaluate expected income levels associated with numerous variables. This is not to say that the income levels are causally related to the program or student variables to be examined in the following tables, but that, given labor supply and demand functions existing at the time and place under study, these income results obtained.

For example, Table 2 shows no significant differences in adjusted mean income among the various male instructional programs.[15] The program planners would likely conclude that there is no apparent reason to curtail or expand a specific program on the basis of data presented in this table. As stated previously, although unadjusted (for covariate influence) income is shown for each level, only adjusted income is used in the analysis. Male and female programs are analyzed separately since each program was mutually exclusive with regard to sex. When statistical adjustments were made for differences in IQ, age, mobility, etc., the estimates of adjusted income were not significantly different from each other.

Possible strategies associated with the interpretation of the remining tables are not so clear-cut as was the case with Table 2. Strategies will vary with the situation and the variables being considered. Certainly, because a higher income level was associated with males in comparison to females, as will be shown in Table 4, female training should not necessarily be discontinued. However, an astute counselor may advise more

Table 1

FACTOR LEVELS AND NUMBER OF OBSERVATIONS

Factor	Level 1	Level 2	Level 3	Level 4	Level 5
1. Instructional Program, Male	Drafting (47)[1]	Welding (41)	Mechanics & Repairmen (120)	Machinists (39)	--
2. Instructional Program, Female	Office Occupations (106)	Cosmetology (6)	Health Occupations (52)	--	--
3. Sex	Male (252)	Female (159)	--	--	--
4. Urban-Rural	Urban (200)	Rural (211)	--	--	--
5. Race	White (371)	Black (40)	--	--	--
6. Relatedness of Training to Occupation	Congruent (209)	Related (33)	Unrelated (59)	No Training Required (110)	--
7. Occupational Mobility	None (294)	Change to Related Jobs (36)	Change to Unrelated Jobs (81)	--	--
8. Post-AVTS Training	None (296)	Less than 3 Months Unrelated to Occupation (35). More than 3 months was coded Level 5 (5).	Less than 3 Months Related to Occupation (33). More than 3 Months was coded Level 6 (16).	1 Year or More College or 1 Year or More College and Other Training (26)	--
9. Geographic Mobility	None or Movement to Adjacent County (363)	Movement at Least 2 Counties from Home but Within State (22)	Other More Distant Movement (26)	--	--

(continued)

Table 1 (Continued)

Factor	Level 1	Level 2	Level 3	Level 4	Level 5
10. Marital Status	Married (280)	Single & Other (131)	--	--	--
11. Level of Educational Attainment	8 Years or Less (29)	9-11 Years (56)	12 Years (297)	13-14 Years (29)	--
12. IQ[2]	90 or Less (53)	91 to 110 (287)	111 & Over (61)	--	--
13. Age in 1968[2]	Younger than 20 (48)	20 and Over (363)	--	--	--
14. Hours of Instruction[2]	300 to 699 Hours (131)	700 to 1099 Hours (97)	1100 to 1499 Hours (66)	1500 to 1899 Hours (27)	1900 Hours and Over (90)

[1]Number of observations shown in parentheses.

[2]When variable was used as a covariate, it was entered into the equations as a continuous variable.

Table 2

MALE INSTRUCTIONAL PROGRAMS

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 4				
Machinists	1508	1503		
Level 3				
Mechanics & Repairmen	1440	1518		
Level 1			None	
Drafting	1577	1536		
Level 2				
Welding	1533	1564		

females to enroll in traditionally male programs on the basis of evidence presented in the table. The remaining tables will not be discussed in terms of counseling or planning action but will only be analyzed in terms of significant differences in income. It is left to the reader to relate the findings to possible strategies. Perhaps more importantly, the authors intend to demonstrate a technique that can be replicated in specific educational systems by educational planners.

Table 3 shows that female students trained in health occupations had significantly higher incomes than those trained in office occupations. Health occupations included primarily training for "Certification occupations" such as licensed practical nurse and certified lab technician.

It can be seen from Table 4 that males were significantly higher in income than females. This is certainly no startling finding, but it is interesting to note the magnitude of the difference. Males earned approximately 70 percent more than females even with labor force participation and unemployment partially controlled by our method of income measurement in addition to covariate control. Whether the income disparity is due to differences in productivity or to cultural barriers is an interesting question which lies beyond the scope of the present paper.

Table 5 shows no significant income differences between former students with rural and urban residences. Urban students were defined as those students who attended high school in cities of 20,000 or more or, when this information was not available, who attended an AVTS school in a county containing a city of 25,000 or more.

Table 6 shows almost identical earnings among blacks and whites in the study population. Vocational education may have effectively reversed employment discrimination. The evidence presented here, albeit meager, is that the acquisition of occupational skills and attitudes may be an economic and social ameliorator of black disadvantagement in the labor market.

Table 7 shows differences in income among the four levels of job relatedness to training. By comparing the occupation reported on the questionnaire with the type of instruction received by the student, it was possible to devise the four cell classification shown in Tables 1 and 6. Level 1 included former students who worked at jobs directly matched to their training; Level 2 included former students who worked at jobs indirectly related to their training, e.g., an auto mechanic trained as a refrigeration mechanic; Level 3 included those with jobs unrelated to their training, e.g., secretary trained as a cosmetologist; Level 4 contained those with jobs that required no formal training; e.g., packager or inspector (garments). Although Level 1 was highest in income as expected, it was significantly different only from Level 4, as were Levels 2 and 3. This finding strongly supports the economic justification of job counseling as a necessary component of vocational education programs.

Table 3

FEMALE INSTRUCTIONAL PROGRAMS

Level (Ranked by Adjusted Income	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 1 Office Occupations	945	843		Level 3
Level 2 Cosmetology	799	946		
Level 3 Health Occupations	1138	1164		Level 1

Table 4

SEX

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 2 Female	984	908	Level 1	
Level 1 Male	1493	1541	Level 2	

Table 5

URBAN-RURAL RESIDENCE

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 2 Rural	1271	1281	None	
Level 1 Urban	1323	1321		

Table 6

RACE

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 1 White	1325	1296	None	
Level 2 Black	1029	1292		

Table 7

RELATEDNESS OF TRAINING TO OCCUPATION

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 4 No Training Required	1102	1080	Level 1,2,3	
Level 2 Related	1450	1311	Level 4	
Level 3 Unrelated	1481	1336	Level 4	
Level 1 Congruent	1322	1396	Level 4	

Table 8 reveals that occupational mobility was not related to income. From information on the questionnaire it was determined whether the former student made no occupational change in 1968--Level 1, changed to a related job--Level 2, or changed to an unrelated job--Level 3. Theoretically, it was expected that occupational change would be positively related to income as workers respond to economic incentives.

Table 9 reveals differences in earnings among former students with different types of training experiences in addition to AVTS training. From the questionnaires the type and duration of any additional formal training or education (including formal OJT programs) was determined and compared with present occupation. Assignment was then made to one of the six levels shown in Table 8. It can be seen that Level 4 was significantly lower than Level 1 and Level 3, while there were no significant differences among the remaining levels (partially due to the small number of observations in these latter categories--see Table 1). Level 1 may have been significantly lower due in part to the inclusion in that category of former AVTS students who were attending college part-time and consequently did not earn at their full potential.

Table 10 reveals significant differences among three levels of geographic mobility. The address of the last public school attended prior to AVTS was obtained from AVTS records and compared with the address given on the questionnaire to determine the three levels shown in Table 10. Level 3 was significantly higher in income than both Levels 1 and 2. This finding tends to support the proposition that economic incentive is associated with distant geographic movement.

Table 11 reveals a significant difference in earnings between married persons and single (and other) persons with married persons being the higher. Actually the difference would probably have been more extreme among males if shown separately and opposite in direction among females who tend to have lower rather than higher participation rates when married. There is strong empirical evidence from other sources to support the preceding, but the partial control of participation inherent to the potential income concept forced the countervailing trends in the direction of an income advantage for married subjects.

Table 12 shows differences among the levels of prior educational attainment. Level of prior educational attainment was obtained from AVTS entry records, and each student was assigned to one of the four levels. The table reflects generally what one would expect to find; high school graduates were significantly higher in earnings than both high school dropouts (Level 2) and grade school graduates and dropouts (Level 1). Again, income for Level 4 was probably depressed because some of the former AVTS students in this category were still attending college part-time.

Table 13 reveals no significant differences among the three levels of IQ although there was a consistent trend toward a positive

Table 8

OCCUPATIONAL MOBILITY

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 2 Change to Related Job	1227	1264	None	
Level 3 Change to Unrelated Job	1329	1293		
Level 1 No Change	1296	1301		

Table 9

POST-AVTS TRAINING

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 4 1 Year College & Other Training	1167	1050	Level 1,3	
Level 1 No Additional Training	1246	1281	Level 4	
Level 3 Less than 3 Months Related to Occupation	1505	1389	Level 4	
Level 5 Over 3 Months Unrelated to Occupation	1529	1393		
Level 6 Over 3 Months Related to Occupation	1598	1402		
Level 2 Less than 3 Months Related to Occupation	1451	1456		

Table 10

GEOGRAPHIC MOBILITY

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 2 Movement Within State	1260	1266	Level 3	
Level 1 None	1268	1272	Level 3	
Level 3 Movement Out of State	1715	1652	Level 2,1	

Table 11

MARITAL STATUS

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 2				
Single	1159	1217	Level 1	
Level 1				
Married	1360	1332	Level 2	

Table 12

LEVEL OF EDUCATIONAL ATTAINMENT

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 2 9-11 Years	1141	1111		Level 3
Level 1 8 Years or Less	1314	1133	Level 3	
Level 4 13-14 Years	1264	1240		
Level 3 12 Years	1327	1352	Level 1	Level 3

Table 13

IQ

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 1 90 or Less	1200	1244		
Level 2 91 to 110	1293	1298	None	
Level 3 111 and Over	1394	1332		

relationship. The lack of a significant relationship here may have been due in part not only to the typical difficulty of IQ measurement but the heterogeneity of measures that were relied upon. In about 25 percent of the cases, IQ scores (although from several different tests) were available directly from high school records. For another 60 percent only the G component of the GATB test was available and used as a proxy for IQ. For the remaining 15 percent of students who had unknown IQ's, the mean IQ of 99 was assigned.

Table 14 reveals no significant differences between the two age levels although the trend is in the expected direction of the young earning less than the old (and is significant at .10).

Table 15 shows differences among levels of hours of instruction. Only two levels were significantly different; income for former students receiving from 300 to 699 hours of AVTS instruction was significantly higher than those receiving 1,900 or more hours. Theoretically, hours of instruction should not be related to income, for the AVTS program was designed to allow students to proceed at their own pace (except in certification fields such as certain health occupations that required 2,150 hours, which dominated Level 5). Hypothetically, the student remained in training until entry level skill was acquired. Thus, students generally reached a common level of proficiency, and other factors being adjusted by the statistical model, one would expect little difference in earnings. However, the heavy over-representation of females in the 1900-hour-and-over category (80 out of the 90 subjects in the category were female) biased downward the estimate of adjusted mean income. The one significant relationship notwithstanding, meager evidence is lent to the proposition that the individual progression system worked.

Summary

The purpose of this paper has been to describe an internal comparison procedure developed by the authors to analyze the effects of various student-related and program-related characteristics on potential income. The procedure was developed as an evaluative alternative to the specific rate of return (and benefit-cost ratio) approach on the one hand and the general, descriptive "follow-up" approach on the other.

The main advantages of the internal comparison procedure lie in the straightforward interpretation of the results, flexibility in kinds of comparisons that can be made, and, most of all, reasonably accurate income estimates. These advantages stem primarily from the sample selection, a well controlled and conceptualized method of data collection (including questionnaire design, response rate, and reliance upon Social Security earnings records), selection of a dependent variable (potential earned income) that offers control on unemployment and labor force participation, and use of a statistical design that allows estimation of individual factor effects independent of covariate influence.

Table 14

AGE IN 1968

Level (Ranked by Adjusted Income	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 1 Less than 20	1043	1181	None	
Level 2 20 and Over	1330	1311		

Table 15

HOURS OF INSTRUCTION

Level (Ranked by Adjusted Income)	Unadjusted Mean Income (Dollars Per Quarter)	Adjusted Mean Income (Dollars Per Quarter)	Significance (Adjusted Income) .05	.01
Level 5 1900 Hours and Over	1187	1180	Level 1	
Level 2 700 to 1099 Hours	1300	1270		
Level 3 1100 to 1499 Hours	1310	1282		
Level 1 300 to 699 Hours	1330	1379	Level 5	
Level 4 1500 to 1899 Hours	1451	1409		

A note of caution must now be extended to the reader regarding the interpretation of the various income hierarchies. Although the relative income position for a given student characteristic or program characteristic may reflect endogenous training efficiencies, it may also be an exogenous effect of the supply and demand functions for the occupations involved.[16] That is to say that an efficient office occupations program may attract able and willing candidates who become proficient secretaries but at low wages due to a local labor market glut. The converse may also be true. Then too, there are institutional barriers against entry and progression in many occupations, although the fact remains that the treatment of adjusted mean income is a valid technique for estimating ordinal income differences among specified categories of vocational students in subsequent labor force experience.

The point to be made is that a program evaluation such as the one reported upon here should be integrated into a larger planning system containing a wide spectrum of knowledge about the structure of the labor markets to be served. This method allows the rigorous and systematic analysis of income in association with program and student characteristics which may serve as a basis for more extensive occupational studies vis-a-vis the labor market.

FOOTNOTES

1. T. W. Schultz, "Capital Formation by Education," Journal of Political Economy, 1960, pp. 575-600.

2. See, for example, the bibliographies reported in J. Robert Warmbrod, Review and Syntheses of Research on the Economics of Vocational-Technical Education (Columbus, Ohio: Ohio State University, The Center for Vocational and Technical Education, November 1968); and M. Blaug, Economics of Education, A Selected Annotated Bibliography (New York: Pergamon Press, 1966).

3. Dale B. Rasmussen, Determinants of Rates of Return to Investment in On-the-Job Training, doctoral dissertation (Dallas: Southern Methodist University, 1969).

4. Michael Borus, John P. Brennan, and Sidney Rosen, "A Benefit-Cost Analysis of the Neighborhood Youth Corps: The Out-of-School Program in Indiana," Journal of Human Resources, Vol. 2, Spring 1970.

5. Laurie M. Sharp and Rebecca Krasnegor, The Use of Follow-Up Studies in the Evaluation of Vocational Education (Washington, D. C.: Bureau of Social Science Research, Inc., May 1966).

6. J. Robert Warmbrod, op.cit., p. 40.

7. For a more complete treatment of the sample and follow-up procedure see: R. L. Bowlby and W. R. Schriver, "Non-Wage Benefits of Vocational Training: Employability and Mobility," Industrial and Labor Relations Review, July 1970.

8. The questionnaire, its design and pretest, and the payment procedure are all treated in detail in R. L. Bowlby and W. R. Schriver, The Effects of Vocational Education on Labor Force Experience in Tennessee (Memphis: Memphis State University, Center for Manpower Studies, February 1971).

9. See Michael Borus, "Response Error in Survey Reports of Earnings Information," Journal of American Statistical Association, September 1966.

10. This assumption, incidentally, is used in computing unemployment benefits in Tennessee and other states.

11. Since rank of income rather than its absolute value is critical in the technique to be employed, further support is lent to the "potential income" concept. An analysis similar to the one reported upon here was performed by the authors using the more conventional average income rather than income potential. The results were generally similar with regard to rank but much larger variances were encountered primarily due to differences in rates of participation and unemployment, particularly among females.

12. The adjusted treatment mean $\bar{Z}$ (adjusted mean income) is defined as follows:

$$\bar{Z}_i = \bar{Y}_i - \hat{\underline{B}}' \, (\bar{\underline{x}}_i - \bar{\underline{x}})$$

where $\bar{Y}_i$ is the unadjusted mean for treatment i;

$\bar{\underline{x}}_i$ is the vector of covariate means for treatment i;

$\bar{\underline{x}}$ is the vector of covariate overall means; and

$\hat{\underline{B}} = E_{xx}^{-1} \, \underline{e}_{xy}$

where E_{xx}^{-1} is the normalized matrix of x's, and

$\underline{e}_{xy}$ is the vector of cross products.

13. H. Scheffé, The Analysis of Variance (New York: John Wiley & Sons, 1959), pp. 68-69, 192-213.

Define: k = number of groups (or samples)

For group i (i = 1, 2, . . ., k)
define n_i = number of observations

$\bar{Z}_i$ = adjusted treatment mean

$\bar{\underline{x}}_i$ = vector of covariate means

further, define

s^2 = residual mean square error based on m degrees of freedom

m = df for s^2

E_{xx} = matrix of "within" sums of squares and products for the covariates.

Then, Scheffé's procedure is to declare any two adjusted treatment means, say, $\bar{Z}_t$ and $\bar{Z}_u$ as significantly different at level of significance a if

$$(1) \quad (\bar{Z}_t - \bar{Z}_u)^2 \Big/ \left\{ (k-1)s^2 \left[\frac{1}{n_t} + \frac{1}{n_u} + (\bar{\underline{x}}_t - \bar{\underline{x}}_u) \, E_{xx}^{-1} (\bar{\underline{x}}_t - \bar{\underline{x}}_u) \right] \right\} > F(a,k-1,m)$$

where F(a,k-1,m) is Snedecor's F with k-1 and m degrees of freedom.

As adapted to the paradigm of the Newman-Keuls and Duncan multiple range procedures, one arranges the adjusted treatment means in order of magnitude:

$$\bar{Z}_{(1)}, \bar{Z}_{(2)}, \ldots, \bar{Z}_{(k)} ,$$

and the largest and smallest means are compared by (1). If this result is not significant, no further comparisons are made. If $\bar{Z}_{(k)}$ is significantly different from $\bar{Z}_{(1)}$ at α = .15, then

$\bar{Z}_{(k)}$ is compared to $\bar{Z}_{(2)}$ at α = .05 and α + .01 with "k" now replaced by k-1 in (1), etc., the test proceeding analogously to the Newman-Keuls and Duncan procedures.

14. In a separate study by the authors, 127 members of the sample were matched with cohorts selected from each member's high school graduation class (matched in IQ, race, sex, age, rank in class, curriculum, and father's occupation when known) who received no vocational training prior to entering the labor force. The two groups were compared in income and an internal rate of return to training investments was computed on the basis of differences in earnings between the two groups by solving for r by summing for each time period i over the expected working life n.

$$\sum_{i=1}^{n} \frac{C_1(i) + C_2(i) + C_3(i) + C_4(i)}{(1 + r)^i} = \sum_{i=1}^{n} \frac{B(i) \times P_1(i) \times P_2(i)}{(1 + r)^i}$$

where: $C_1(i)$ = public capital cost in time period i;

$C_2(i)$ = public operating cost in time period i;

$C_3(i)$ = private capital cost in time period i;

$C_4(i)$ = private operating cost in time period i;

$B(i)$ = expected difference in earnings (benefits) in time period i;

$P_1(i)$ = probability of being alive in time period i;

$P_2(i)$ = probability of participating in the labor force in time period i.

The r that set the cost stream (left side of equation) equal to the benefit stream (right side of equation) was defined as the internal rate of return and was computed to be 6.3 percent for our study population. The private return (removing C_1 and C_2 from the above equation) was 13.4 percent.

For a complete treatment, see the authors' report to the U. S. Office of Education, An Analysis of Differential Benefits from Vocational Training, OEG-4-70-0053, January 1971.

The rate of return procedure allows one to estimate the effects of vocational training. The internal comparison procedure described in this paper allows short-run comparisons of relative income levels of one category of trainees vis-a-vis another category.

15. The significance columns are to be read as follows. Levels shown in the .05 or .01 significance columns are significantly different in adjusted income from the corresponding row level shown in column 1. The word "none" in the significance columns indicates that no computed F ratio exceeded the critical F value at the 95th percentile and/or that the computed F ratio comparing the

two extreme levels did not exceed the critical F value at the 85th percentile. (See footnote 12.)

16. For a more thorough and theoretical treatment of supply-oriented versus demand-oriented educational planning models, see Mary Jean Bowman, "Economics of Education," Review of Educational Research, Vol. 39, No. 1, December 1969.

APPENDIX D

THE EFFECT OF VOCATIONAL TRAINING ON THE INCOME-EDUCATION DISTRIBUTION

By William R. Schriver and Roger L. Bowlby*

Introduction

A positive association between educational attainment and earnings for the individual has been well established and verified by many statistical studies.[1] In spite of this extensive investigation, the cause and effect relationships underlying the association are not well understood. The purpose of this paper is to advance this understanding.

For the individual (though not necessarily the family unit) the statistical association must be interpreted as an indication that the chain of causality (if it exists) goes from more education as a cause to higher income as a result, since the education takes place earlier in time than the income receipt. This cause and effect relationship will be assumed without proof, and the mechanism through which it operates will be investigated. Improved understanding of the process might assist educators in strengthening the relationship between education and income or in devising substitutes for formal education that will produce a similar effect.

We could imagine a world in which social status determined income, and education raised income for the individual by a purely sociological route. In the real world we can observe arbitrary levels of formal education required for entry to a wide variety of jobs, without much reference to job characteristics or performance.[2] The arbitrary promotion of workers to higher levels of pay and responsibility on the basis of their educational levels no doubt occurs in the real world and augments the force of these arbitrary entrance requirements. At the extreme one could imagine that education enhances income only by improving prestige and that a cleverly forged high-school diploma, C.P.A. certificate, medical degree or plumber's license is exactly as effective in terms of income as the same degree earned through long apprenticeship and expensive study.

Most economists will feel somewhat more comfortable in imagining a contrasting social order in which economic productivity determines income to the exclusion of social prestige. In this world, well-trained plumbers, doctors and accountants will receive higher incomes than impostors because of their higher marginal revenue productivity. The market mechanism will tend to produce this result by the elimination of inefficient firms, so that hiring prestigeful incompetents will prove self-destructive and short-lived.

Data to test these competitive models were generated in a cost-benefit study of Tennessee's Area Vocational-Technical Schools conducted by the authors of the present article during 1968 and 1969.[3] The students at these schools

were drawn from an educationally diverse population with a range from 1 to 16 years of formal education.

If prestige can be equated with education, they should cover almost the entire noncollegiate spectrum. They received training in such vocational subjects as drafting, welding, mechanics, and machine shop. We assume that this training increased their productivity, but left their prestige unchanged. On this assumption we can shed some light on the realism of the "prestige"[4] theory of wages and the productivity theory of wages as outlined in the previous paragraphs.

In practice it may be difficult to maintain a rigid distinction between vocational training and formal education, since even the most strongly trade-oriented programs will have some "cultural" content[5] and some "practical" elements are likely to creep into the most academic of curricula. Levitan and Mangum (p.33) appear to disavow the distinction, and state that "the most valuable contribution education and training can make to preparation for employment is the same one it performs in preparation for other aspects of life: ability to communicate and compute." We must nevertheless make such a distinction which seems easy to justify by the contrast between the Tennessee Area Vocational-Technical Schools and the public school system of the State.

The economic consequences of vocational training have also been studied extensively, and it seems fair to state that a positive association is well established between the receipt of vocational training and subsequent income.[6] If vocational training and formal education increase income, the interaction between the two variables becomes more difficult to measure, and a number of the relationships become important from a policy standpoint. Given a fixed dollar sum for education and training, we might wish to allocate it between education and training in a way that will maximize the resultant income increases for the trained and the educated.[7] Given a fixed sum for training, the same maximization goal might lead us to spend it on students already highly educated or on students with low levels of formal education. There are logical reasons for either choice. We might suppose that the payoff will be greater to the educated, since their presumed higher level of ability will enable them to learn more and capitalize this learning. The payoff could also be greater to those of low educational ability since their presumed lower income levels will leave more room for improvement, and since a given absolute increase would be larger in ratio terms.

Our information about Tennessee AVTS students will permit a reasonably straightforward answer to this latter policy problem, namely the allocation of fixed vocational training dollars among various educational levels. The resolution of this practical problem, in turn, will shed some light on the theoretical questions raised earlier.

The Data

"Potential income" in 1968 was estimated for vocationally-trained individuals on the basis of a 25 percent random sample of former students at

19 Tennessee Area Vocational-Technical Schools. The age of each individual and his years of formal schooling were determined from school records, and his "potential income" in 1968 was determined by an examination of his social security record, obtained by an individual authorization as part of a mailed questionnaire.[8] Almost all the subjects were covered by social security; for about two percent of the respondents with railroad or uncovered government employment the respondent's own statement of his current wage rate was substituted, multiplying by a factor to convert it to a quarterly sum, the calendar quarter being the unit of account for the social security earnings figures.

Income potential for 1968 was determined by taking each individual's highest quarter of earnings since leaving school and multiplying by four. Each student had at least four quarters from which to select the high quarter, and the median student had nine. The high quarter was used in preference to earnings over time on the assumption that training will influence earning capacity more directly than actual earnings, and also in order to eliminate the influence of participation rates and unemployment rates upon earnings so far as possible.[9] The resulting data for 233 vocationally-trained subjects are presented in Table 1. A few limitations may be noted here. Many students were excluded more or less arbitrarily from the random sample of 1,701 drawn from school records in 1968, including females, those who left school too late to have a full year of labor force experience, those with less than three months of vocational schooling in AVTS, college attenders, servicemen, and a number of subjects attending school with the assistance of the State vocational rehabilitation agency, who were presumed to suffer physical disability. Aside from these deliberate exclusions, the nonrespondents to the mailed questionnaire were inadvertently excluded. Since the response rate exceeded 70 percent[10] and the nonrespondents exhibited the same economic and social characteristics as the respondents, it was concluded that nonresponse was not an important source of error.[11] Less than one percent of the responders refused to sign the social security authorization.

The sample of 233 is believed to be representative of the students who left Tennessee's Vocational-Technical Schools before January 1, 1968, subject to the deliberate exclusions mentioned earlier. Since the group is so heterogeneous in age and years of formal schooling, it is believed that in range, though not necessarily in proportion, it is broadly representative of the noncollegiate labor force of the United States.

The second data requirement is for an estimate of earnings by years of formal schooling and age for the vocationally untrained population. This requirement is satisfied less than perfectly by a census monograph by Weitzman and Ono, the source for the data in Table 2.[12] The table is a straight-line projection of the data for earlier years in the census monograph. Each cell in Table 2 represents mean annual income for a male with a specific year of age and level of educational attainment. The total population is clearly an imperfect representation of the untrained population, and the data can be defended only by the assertion that they are the best that it was possible to obtain. The dollar amounts in Tables 1 and 2 are not comparable for a number of reasons. The census data include property income while the AVTS figures are restricted to wages and salaries.[13] Zero incomes are not counted

Table 1

MEAN ANNUAL EARNING POTENTIAL OF AVTS TRAINED MALES BY AGE AND EDUCATION[1]

Age	Education			
	Less Than 8 Years	8 Years	9-11 Years	12 Years
18	--[a]	--	--	$ 3,798.76 (2)
19	--	--	--	5,214.74 (11)
20	$6,097.12 (1)	$3,456.00 (1)	$4,896.38 (2)	5,443.68 (22)
21	3,544.72 (1)	3,067.97 (3)	4,313.09 (12)	5,756.30 (35)
22	--	5,792.54 (2)	5,225.49 (6)	6,115.92 (15)
23	4,055.80 (1)	3,720.00 (1)	5,249.70 (2)	6,929.85 (10)
24	--	--	--	6,433.39 (14)
25	--	9,796.60 (1)	7,552.35 (4)	6,877.82 (10)
26	--	--	3,300.00 (1)	6,450.88 (8)
27	--	--	--	7,334.25 (7)
28	4,081.24 (1)	4,776.68 (2)	3,308.82 (2)	7,974.39 (4)
29	--	--	--	8,267.61 (9)
30	--	--	5,455.88 (1)	7,131.58 (4)
31	--	5,917.77 (3)	1,540.68 (2)	6,226.74 (4)
32	5,706.44 (1)	--	--	8,596.52 (2)
33	--	--	--	1,006.24 (1)
34	--	--	7,491.24 (2)	6,039.68 (2)
35	5,859.92 (1)	--	--	5,160.00 (1)
36	4,164.00 (1)	--	3,199.24 (1)	4,398.24 (2)
38	--	5,589.92 (1)	--	13,219.07 (2)
40	--	--	--	6,646.60 (1)
41	--	--	--	7,468.56 (2)
42	--	--	6,000.00 (1)	--
47	4,429.16 (1)	--	--	--
50	--	--	--	0.00 (1)
51	--	9,263.36 (1)	--	--
53	--	--	7,790.96 (1)	--
54	5,775.72 (1)	--	--	--
56	6,081.80 (1)	--	--	--
57	--	7,680.48 (1)	--	--
60	--	--	4,320.00 (1)	--
Mean	4,979.59 (10)	5,550.12 (16)	4,956.80 (38)	6,278.18 (169)

[1] Number of observations shown in parentheses.

[a] No observations.

Table 2

ESTIMATED INCOME FOR MALES IN 1968
BY AGE AND EDUCATION

Age	Education			
	Less Than 8 Years	8 Years	9-11 Years	12 Years
18	$1,592.17	$2,101.60	$ 573.32	$1,775.00
19	1,898.44	2,421.82	1,215.67	2,379.00
20	2,188.17	2,728.57	1,822.00	2,953.00
21	2,460.48	3,019.68	2,394.07	3,495.00
22	2,713.42	3,302.59	2,933.86	4,008.00
23	2,954.42	3,565.06	3,439.34	4,490.00
24	3,177.06	3,819.39	3,913.27	4,941.00
25	3,383.42	4,053.67	4,348.58	5,262.00
26	3,572.61	4,280.23	4,751.98	5,753.00
27	3,753.38	4,493.05	5,116.58	6,113.00
28	3,897.41	4,683.33	5,449.93	6,442.00
29	4,037.86	4,867.00	5,750.07	6,741.00
30	4,155.15	5,038.03	6,012.00	7,007.00
31	4,249.47	5,188.98	6,222.45	7,227.00
32	4,323.35	5,322.75	6,381.38	7,403.00
33	4,374.94	5,446.04	6,502.06	7,543.00
34	4,409.28	5,557.53	6,583.30	7,655.00
35	4,436.73	5,652.39	6,651.23	7,743.00
36	4,446.73	5,736.21	6,689.64	7,815.00
37	4,458.95	5,806.08	6,727.81	7,878.00
38	4,461.71	5,874.86	6,771.96	7,939.00
39	4,474.23	5,930.96	6,811.40	8,004.00
40	4,490.25	5,984.31	6,684.60	8,076.00
41	4,503.63	6,018.41	6,926.68	8,144.00
42	4,503.45	6,037.41	6,988.95	8,203.00
43	4,507.23	6,050.91	7,041.51	8,255.00
44	4,505.81	6,057.54	7,086.49	8,298.00
45	4,499.82	6,049.75	7,124.71	8,333.00
46	4,488.78	6,035.20	7,146.94	8,359.00
47	4,464.94	6,023.06	7,170.71	8,377.00
48	4,453.50	5,996.70	7,179.27	8,387.00
49	4,428.33	5,979.93	7,179.27	8,387.00
50	4,398.45	5,956.75	7,163.19	8,378.00

(Continued)

Table 2 (Continued)

Age	Education			
	Less Than 8 Years	8 Years	9-11 Years	12 Years
51	$4,372.80	$5,927.95	$7,140.29	$8,361.00
52	4,333.68	5,892.14	7,108.90	8,334.00
53	4,291.10	5,859.80	7,063.30	8,300.00
54	4,251.84	5,820.48	7,017.60	8,256.00
55	4,200.45	5,775.61	6,956.99	8,204.00
56	4,153.44	5,725.23	6,889.82	8,144.00
57	4,101.59	5,676.02	6,814.45	8,074.00
58	4,038.48	5,613.89	6,725.47	7,997.00
59	3,970.82	5,544.91	6,628.58	7,910.00
60	3,907.50	5,478.31	6,525.52	7,815.00
61	3,840.08	5,405.41	6,407.84	7,711.00
62	3,761.50	5,326.89	6,284.37	7,599.00
63	3,686.16	5,248.85	6,153.57	7,477.00
64+	3,600.52	5,165.64	6,010.66	7,348.00

in the census but a few zero earnings have been included in the AVTS figures. No low earnings periods have been excluded from the census means in order to bring actual figures up to their potential. These (and other) discrepancies mean that while the figures in each Table can legitimately be interpreted as index numbers and compared with other numbers in the same Table, a comparison of absolute magnitude between a number in Table 1 and the comparable number in Table 2 has no meaning.

Analysis

Figure 1 summarizes the means for each educational level from Tables 1 and 2, and the principal problem of this article can be posed in terms of the geometric properties of this figure. Each of the four points on the AVTS line is a column mean from Table 1; each point on the national line is a synthetic mean derived by weighting each cell in Table 2 by the corresponding number of observations (in many cases zero) from Table 1 to produce four more column means reflecting the identical age and educational distribution of the first four.

Since the vertical axis is somewhat arbitrary, and has a different significance for the two samples, no importance should be attached to the slope of the lines, the distance between them, or the fact that the AVTS curve is higher than the national curve. The only meaningful question that can be asked about Figure 1 is whether or not the lines are parallel. The visual evidence suggests the hypothesis that the lines are in fact parallel, which implies the substantive conclusion that vocational training does not alter the income-education distribution already established by the school system before post-secondary vocational training is administered.

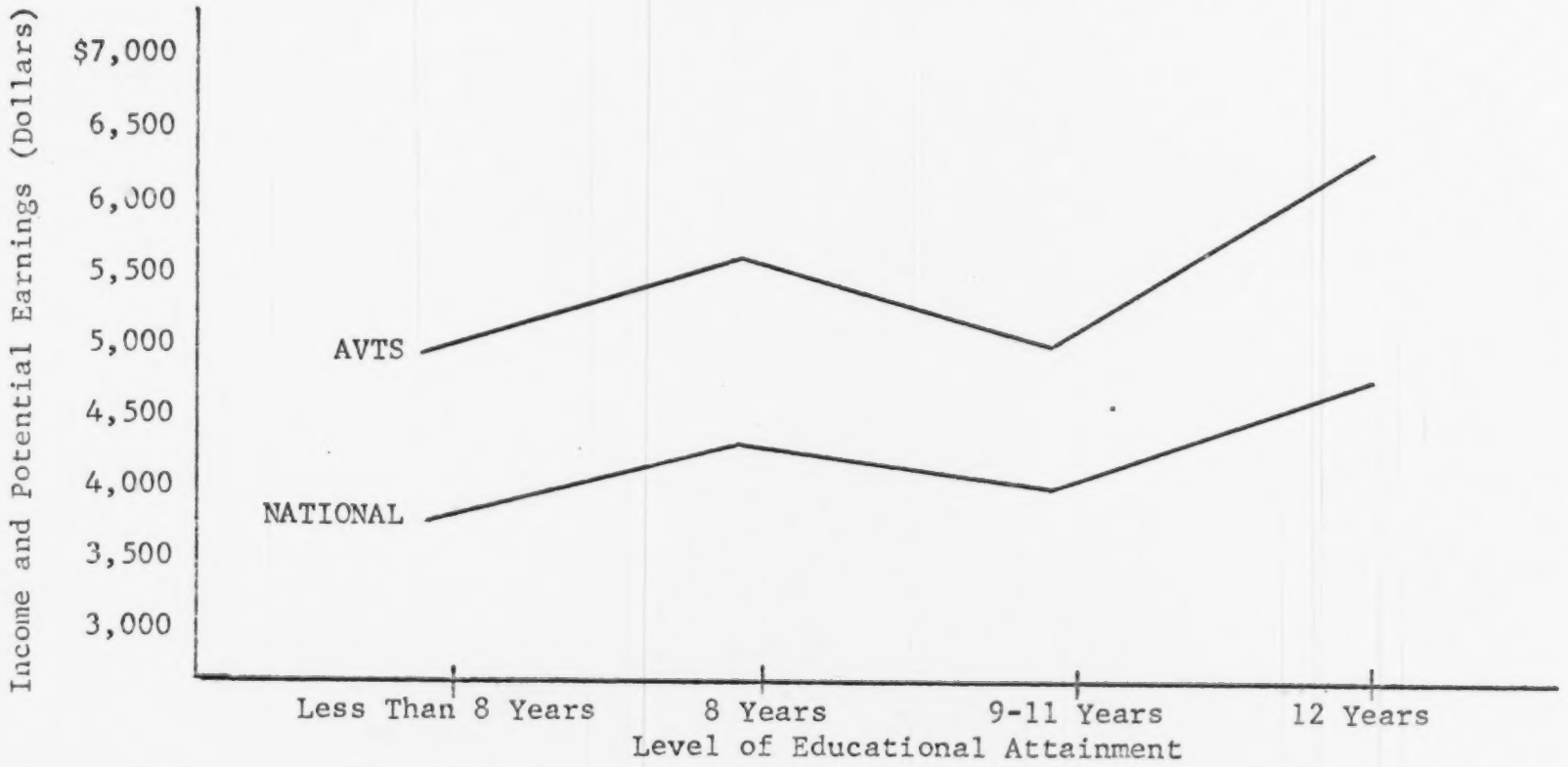
Two statistical tests can be performed on the data to test this hypothesis. The first involves the transformation of each dollar figure in Table 2 into a percentage of the high-school graduate's income at the same age. The results appear in Table 3. The data in Table 1 can be transformed in a similar manner, and the results are shown in Table 4. The Tables can now be compared since each observation is an index number on the same base. Figure 2 summarizes Tables 3 and 4 in the same way that Figure 1 summarizes Tables 1 and 2. In terms of the geometry of Figure 2, the substantive conclusion that all educational groups realize equal income gains would be completely confirmed if the two lines coincided.

The AVTS sample size has been reduced from 64 members with less than 12 years of schooling in Table 1 and Figure 1 to 56 in Table 4 and Figure 2, since each cell in Table 4 requires a high-school graduate and nongraduate with exactly the same age. The 169 high-school graduates shown in Table 1 and Figure 1 have also been effectively lost by their conversion to the base of the index number system.

Since income is a function of age as well as education, and since age and income do not vary together in the same way for the trained and untrained populations,[14] it is necessary to make a further adjustment for age in order

Figure 1

THE RELATIONSHIP OF EDUCATIONAL ATTAINMENT TO INCOME IN THE NATION AND EARNINGS POTENTIAL TO EDUCATIONAL ATTAINMENT IN THE AVTS SAMPLE



MEANS BY EDUCATIONAL LEVEL FOR ALL AGES

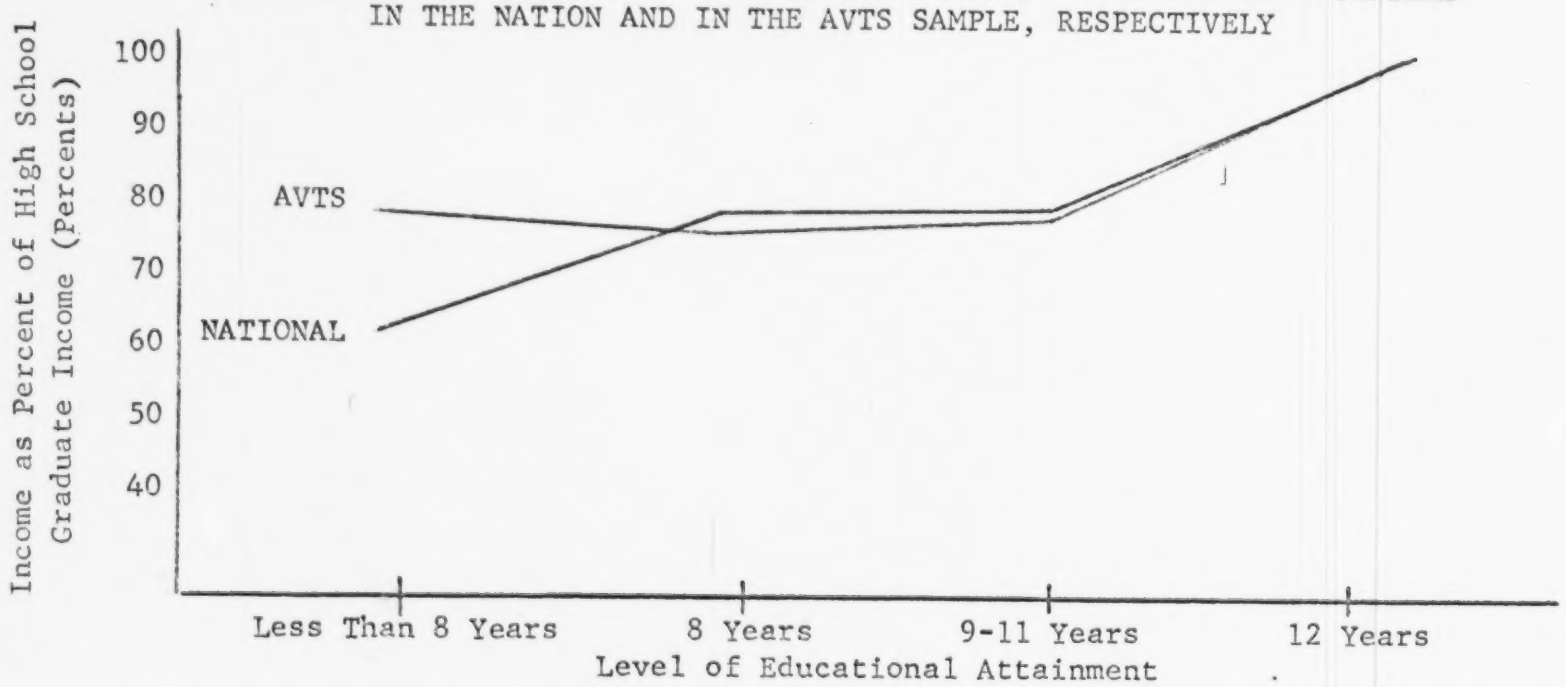
$3,761.75[a]	$4,276.50	$3,915.57	$4,654.82 National
$4,979.59 (10)[b]	$5,550.12 (16)	$4,956.80 (38)	$6,278.18 (169) AVTS

[a]The mean income for the national population was computed from Table 2 by weighting each age category by the number of AVTS observations in that category (Table 1).

[b]Number of observations at all ages shown in parentheses.

Figure 2

THE RELATIONSHIP OF EDUCATIONAL ATTAINMENT TO INCOME AND EARNINGS POTENTIAL AS PERCENTAGES OF HIGH SCHOOL GRADUATE INCOME AND EARNINGS POTENTIAL IN THE NATION AND IN THE AVTS SAMPLE, RESPECTIVELY



MEANS BY EDUCATIONAL LEVEL FOR ALL AGES

63.44[a]	79.01	79.15	100.0	National
79.70 (7)[b]	77.29 (14)	78.95 (35)	100.0	(159) AVTS

[a] The mean percentages for the national population were computed from Table 3 by weighting each age category by the number of AVTS observations in that category (Table 4).

[b] Number of observations of all ages shown in parentheses.

Table 3

ESTIMATED INCOME FOR MALES IN 1968 BY AGE AND EDUCATION AS A PERCENT OF INCOME OF HIGH SCHOOL GRADUATES[1]

	Education			
Age	Less Than 8 Years	8 Years	9-11 Years	12 Years
18	89.70	118.40	32.30	100.0
19	79.80	101.80	51.10	100.0
20	74.10	92.40	61.70	100.0
21	70.40	86.40	68.50	100.0
22	67.70	82.40	73.20	100.0
23	65.80	79.40	76.60	100.0
24	64.30	77.30	79.20	100.0
25	63.10	75.60	81.10	100.0
26	62.10	74.40	82.60	100.0
27	61.40	73.50	83.70	100.0
28	60.50	72.70	84.60	100.0
29	59.90	72.20	85.30	100.0
30	59.30	71.90	85.80	100.0
31	58.80	71.80	86.10	100.0
32	58.40	71.90	86.20	100.0
33	58.00	72.20	86.20	100.0
34	57.60	72.60	86.00	100.0
35	57.30	73.00	85.90	100.0
36	56.90	73.40	85.60	100.0
37	56.60	73.70	85.40	100.0
38	56.20	74.00	85.30	100.0
39	55.90	74.10	85.10	100.0
40	55.60	74.10	85.00	100.0
41	55.30	73.90	85.20	100.0
42	54.90	73.60	85.20	100.0
43	54.60	73.30	85.30	100.0
44	54.30	73.00	85.40	100.0
45	54.00	72.60	85.50	100.0
46	53.70	72.20	85.50	100.0
47	53.30	71.90	85.60	100.0
48	53.10	71.50	85.60	100.0
49	52.80	71.30	85.60	100.0
50	52.50	71.10	85.60	100.0

(Continued)

Table 3 (Continued)

Age	Education			
	Less Than 8 Years	8 Years	9-11 Years	12 Years
51	52.30	70.90	85.40	100.0
52	52.00	70.70	85.30	100.0
53	51.70	70.60	85.10	100.0
54	51.50	70.50	85.00	100.0
55	51.20	70.40	84.80	100.0
56	51.00	70.30	84.60	100.0
57	50.80	70.30	84.40	100.0
58	50.50	70.20	84.10	100.0
59	50.20	70.10	83.80	100.0
60	50.00	70.10	83.50	100.0
61	49.80	70.10	83.10	100.0
62	49.50	70.10	82.70	100.0
63	49.30	70.20	82.30	100.0
64+	49.00	70.30	81.80	100.0

[1] Derived from Table 2 by dividing each cell in a row by the last column cell in the row (12 years of education).

Table 4

MEAN EARNINGS POTENTIAL OF MALE AVTS TRAINED PUBLIC SCHOOL DROPOUTS AS A PERCENT OF AVTS TRAINED HIGH SCHOOL GRADUATES[1]

	Education			
Age	Less Than 8 Years	8 Years	9-11 Years	12 Years
20	112.00 (1)[a]	63.49 (1)	89.95 (2)	100.00 (22)
21	61.58 (1)	70.67 (3)	74.93 (12)	100.00 (35)
22	--[b]	94.71 (2)	85.44 (6)	100.00 (15)
23	58.53 (1)	53.68 (1)	75.75 (2)	100.00 (10)
24	--	--	--	100.00 (14)
25	--	116.27 (1)	109.81 (4)	100.00 (10)
26	--	--	51.16 (1)	100.00 (8)
27	--	--	--	100.00 (7)
28	51.18 (1)	59.90 (2)	41.49 (2)	100.00 (4)
29	--	--	--	100.00 (9)
30	--	--	76.50 (1)	100.00 (11)
31	--	95.04	24.74 (2)	100.00 (4)
32	66.38 (1)	--	--	100.00 (2)
33	--	--	--	100.00 (1)
34	--	--	124.03 (2)	100.00 (2)
35	113.56 (1)	--	--	100.00 (1)
36	94.67 (1)	--	72.74 (1)	100.00 (2)
38	-	42.29 (1)	--	100.00 (2)
Mean	79.7 (7)	77.29 (14)	78.95 (35)	

[1] Derived from Table 1 by dividing each cell (with observations) in a row by the last column cell in the row (12 years of education).

[a] Number of observations shown in parentheses.

[b] No observations.

to carry out the first statistical test. The test involves the fitting of a least-squares regression line to the data for the 56 AVTS students shown in Table 4, and the fitting of another line to an equal number of observations for the same educational level and single year of age drawn from Table 3. The two equations thus produced can be compared by the method suggested by Chow for testing equality between regression coefficients.[15]

With percent of high-school graduate income as the dependent variable and dummy variables representing education and age as the independent variables, the regression equation and standard deviations are as follows for the 56 AVTS students:

$$\hat{Y}_{AVTS} = 93.5\,X_o + 1.92\,X_1 + 2.83\,X_2 - 17.94\,X_3 - 21.36\,X_4 \qquad (1)$$

S.D. 17.67 15.84 17.03 17.99

Where X_o = 0 for less than 8 years education and 34 years of age and over (intercept).
X_1 = 1 for 8 years education and 0 for other.
X_2 = 1 for 9-11 years education and 0 for other.
X_3 = 1 for 23 years of age or less and 0 for other.
X_4 = 1 for 24-33 years of age and 0 for other.

The same dummy and dependent variables yield the following result for 56 observations drawn from the national means in Table 3.

$$\hat{Y}_{NAT} = 65.31\,X_o + 16.04\,X_1 + 12.64\,X_2 - 4.26\,X_3 - .48\,X_4 \qquad (2)$$

S.D. 3.45 3.09 3.32 3.51

Equations (1) and (2) can now be compared by the Chow test, which gives a computed F of .44. The critical F at the .05 level is greater than 2.29, so the null hypothesis cannot be rejected, and there is a high probability that both groups of observations belong to the same regression model. Translating this test into the geometry of Figure 2, it is reasonably probable that the two lines in fact coincide, and so the substantive finding that post-secondary training leaves the income-education distribution unchanged can be maintained.

The second statistical test can be conducted by dividing each cell in Table 1 (representing a specific year of age and level of education) by the analogous cell in Table 2 and multiplying by 100. The resulting matrix is shown in Table 5. It shows AVTS earnings as a percentage of income for the national population. No significance should attach to the fact that the percentages are more than 100, for the dollars in Table 1 are not comparable to the dollars in Table 2. The importance of the numbers lies in their trend line as the level of formal education increases. Again the results can be summarized in a simple geometric figure and interpreted intuitively. Figure 3 shows the means from Table 5, and compares the earnings of trained and untrained people at each educational level. A rising curve would indicate that vocational training yields higher benefits for better educated people, while

Table 5

EARNING POTENTIAL OF AVTS MALES BY AGE AND EDUCATION AS A PERCENT OF 1968 INCOME ESTIMATES BY AGE AND EDUCATION[1]

Age	Education			
	Less Than 8 Years	8 Years	9-11 Years	12 Years
18	--[a]	--	--	214.08 (2)[b]
19	--	--	--	219.59 (11)
20	278.64 (1)	126.66 (1)	268.74 (2)	184.34 (22)
21	144.07 (1)	134.72 (3)	180.16 (12)	164.70 (35)
22	--	175.39 (2)	178.11 (6)	152.59 (15)
23	137.28 (1)	104.35 (1)	162.64 (2)	154.34 (10)
24	--	--	--	130.20 (14)
25	--	197.27 (1)	173.67 (4)	128.27 (10)
26	--	--	69.44 (1)	112.13 (8)
27	--	--	--	119.98 (7)
28	104.72 (1)	101.99 (2)	60.71 (2)	123.79 (4)
29	--	--	--	122.65 (9)
30	--	--	90.75 (1)	101.78 (4)
31	--	114.04 (3)	24.76 (2)	86.16 (4)
32	131.99 (1)	--	--	116.12 (2)
33	--	--	--	13.34 (1)
34	--	--	113.79 (2)	78.90 (2)
35	132.08 (1)	--	--	66.64 (1)
36	93.64	--	47.82 (1)	56.28 (2)
38	--	95.15 (1)	--	166.51 (2)
40	--	--	--	82.30 (1)
41	--	--	--	91.71 (2)
42	--	--	85.85 (1)	--
47	99.20 (1)	--	--	--
50	--	--	--	0.0 (1)
51	--	156.27 (1)	--	--
53	--	--	110.30 (1)	--
54	135.84 (1)	--	--	--
56	146.43 (1)	--	--	--
57	--	135.31 (1)	--	--
60	--	--	66.20 (1)	--
Mean	140.39 (10)	132.26 (16)	148.34 (38)	147.16 (169)

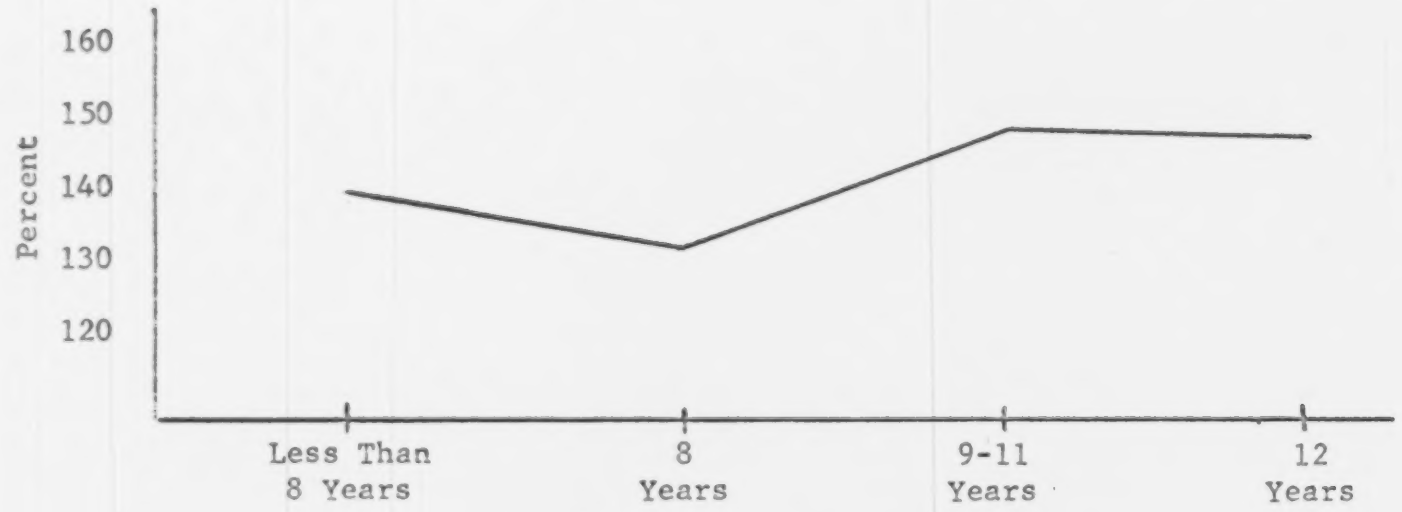
[1] Derived by dividing each cell in Table 2 (with observations) by the analogous cell in Table 1.

[a] No observations.

[b] Number of observations shown in parentheses.

Figure 3

THE EDUCATION-INCOME DISTRIBUTION OF THE AVTS SAMPLE AS A PERCENTAGE OF THE EDUCATION-INCOME DISTRIBUTION OF THE NATIONAL POPULATION



MEANS BY EDUCATIONAL LEVEL FOR ALL AGES

Less Than 8 Years	8 Years	9-11 Years	12 Years
140.39	132.26	148.34	147.16

a negative slope would support the opposite conclusion. The general appearance of the graph suggests the hypothesis that the curve is flat, which implies that vocational training yields equal proportionate benefits for the four educational groups, the same finding tentatively established by the first test.

Again a regression model can be used to test the conclusion based on the graph and to take age into account, which is not controlled in the two-dimensional figure and which might account for the observed relationship. The regression equation obtained from the data in Table 5 is:

$$\hat{Y} = 114\ X_o - 21.85\ X_1 - 14.27\ X_2 - 20.94\ X_3 + 75.31\ X_4 + 19.20\ X_5 \quad (3)$$

S.D.		23.84	21.18	19.79	13.27	14.15
t		.92	.67	1.06	5.67	1.36

Where X_o = 0 for less than 8 years education and 34 years old and over and 0 for other (intercept).
X_1 = 1 for 8 years of education and 0 for other.
X_2 = 1 for 9-11 years of education and 0 for other.
X_3 = 1 for 12 years of education and 0 for other.
X_4 = 1 for 23 years of age and under and 0 for other.
X_5 = 1 for 24 to 33 years of age and 0 for other.

None of the t scores for the educational variables are significantly different from zero at the .10 confidence level. This confirms our first test and indicates that vocational training distributes its benefits equally among all the educational groups. In terms of Figure 3, it is indeed probable that the graph is a flat one with zero slope at every point. The significant coefficients for the two age variables have no clear interpretation in terms of the distribution of the benefits of vocational training.[16]

To summarize, neither of the tests show significant changes in the income-education distribution as a result of training. Training at Tennessee Area Vocational-Technical Schools seems to increase the earning potential of elementary school dropouts, elementary school graduates, high-school dropouts and high-school graduates, by a constant proportion. This hypothesis remained intact after two tests that might have led to its rejection. In the first test, a least-square equation of income as a percent of high-school graduates income regressed on education as a residual of age among a group of AVTS students did not significantly differ from a least-squares equation of a similarly composed education-income distribution representing the national population. In the second test an AVTS matrix of income by age and education divided cell by cell by a similar matrix representing the national population generated a matrix of ratios whose least-squares regression line (income regressed on education as a residual of age) was not significantly different from zero in slope.

Inability to disprove a statistical hypothesis should never be confused with proving its truth, but it may indicate that the hypothesis is worthy of further testing. Such an indication seems warranted here.

There is no reason to believe that our Tennessee data are far removed from the results that would be produced by collection of similar data for the entire United States. As noted earlier, the subjects covered the non-collegiate age-education spectrum. They also included students from a metropolitan area of a half-million and students from relatively isolated rural communities, a proportion of Negro students not greatly different from the proportion in the general population, and a diversity of instructional programs of various lengths and degrees of difficulty. The extension of findings based on Area Vocational-Technical Schools to other forms of adult vocational training, such as MDTA programs, registered apprenticeship programs, and much training in the armed forces seems not unreasonable on the same grounds.

Conclusion

From a policy standpoint, the findings have both negative and positive implications for vocational education. While there is no reason to question the efficacy of training as an antipoverty device if poverty is conceived in absolute terms, the Tennessee experience suggests that if poverty is defined in terms of inequality (as by a Lorenz curve, which is not affected by the level of income) then vocational training will fail as an antipoverty measure. In this respect training may differ from formal schooling, for there is at least some evidence that an overall increase in levels of formal education will lead to greater equality in income distribution.[17]

The proportionate gains realized by workers at low educational levels may serve as a warning against the dismissal of low ability and culturally deprived workers as "functional illiterates," or "unemployables." The fact that poorly educated students can achieve equal income increases could even be interpreted as a testimonial to the efficacy of vocational training, for these gains are doubtlessly won in spite of very real obstacles.[18] The Tennessee experience gives no ground for quarrel with the policy recommendation of Hansen, Weisbrod and Scanlon that improved vocational training will prove more effective than longer formal schooling for students of low ability, though this decision may ultimately rest on cost considerations beyond the scope of the present article.

The stability of the income-education distribution in spite of the influence of vocational training suggests the importance of sociological variables in income distribution and implies that formal schooling may influence lifetime income by improving prestige as well as by improving productivity. Given only the evidence presented thus far, one's conclusion on this point cannot consist of much more than supposition, for the observed facts can be explained either by vocational training increasing everyone's productivity in equal ratio or by vocational training producing some other result, which is nullified by a prestige effect.

It is the authors' conclusion, however, that the second explanation comes nearer the truth. If the AVTS students learned a marketable skill that skill should have the same dollar value for an elementary school

dropout or a high-school graduate. That each student acquired the same skill is a reasonable assumption in terms of the school operations. Entering students elected a vocational goal, such as auto mechanics. The instruction was highly individualized, and though the auto class lasted two years, students were encouraged to leave school as soon as they became employable in their chosen field. Few of them stayed for the whole two years, and if the system worked properly the main difference between the best students and the worst students was the length of stay, and not the amount learned.[19] If this is the case, and if incomes are a strict function of productivity, one would expect income increases to be an arithmetic constant, and the income distribution to be changed. This result, anticipated by the authors, was not reached in the analysis, notwithstanding two attempts to discover significant shifts.

This does not mean that marginal productivity cannot explain the observations, but simply that other explanations are more satisfactory to the present investigators. We can offer no better conclusion than a quotation from Barbara Wootton (p. 161):

> The contemporary wage and salary structure . . .
> (is) the accumulated deposit laid down by a
> rich mixture of economic and social forces,
> operating through considerable periods of
> history. . . .
> At every point the economic and sociological
> forces act and react upon one another to
> produce a result which is quite explicable
> if either is left out of the reckoning.

FOOTNOTES

*The research described here was supported by a grant from the United States Office of Education (OEG-470-0053). The authors are indebted to Charlie M. Dunn, Tennessee Assistant Commissioner for Vocational-Technical Education, for financial support and cooperation in generating the data reported upon, and to Feng-Yao Lee of the Economics Department, University of Tennessee, for statistical advice.

[1]Miller (10) may be cited as a leading authority; the bibliography on this point is quite extensive.

[2]See, for example, Diamond and Bedrosian, (7). Requirement of a license for entry into an occupation may be analytically likened to an arbitrary requirement of formal schooling.

[3]The final report of this study will be published in 1971; a description of the data more complete than the sketch in the present article can be found in Bowlby and Schriver (3).

[4]Hausen, Weisbrod and Scanlon (8) refer to a "Sheepskin effect" that seems quite close to our "prestige effect," but they are unable to confirm its existence on the basis of their data.

[5]For example, the Bureau of Apprenticeship and Training requires "related instruction" usually offered through the public school system as a prerequisite for the registration of a union-management apprenticeship program.

[6]See, for example, Carroll and Ihnen (4), Corazzini (6), Taussig (13), Somers and Stromsdorfer (12), and Borus (2).

[7]Some data bearing on this question were presented by Hansen, Weisbrod and Scanlon (8). For students of low ability, their analysis "suggest the wisdom of expanding training facilities rather than simply urging school attendance." (p.417)

[8]The other (extensive) information about each former student collected from the questionnaire and school records (not used in the present analysis) will be presented in our final report.

[9]Bowlby and Schriver (3) examine these questions extensively.

[10]This high rate can be partly explained by the facts that nonrespondents received three mailed follow-ups and that a cash payment of 50¢ for completing the questionnaire was sent with the first mailing.

[11]The nonrespondents resembled the respondents very closely in age, the length of their vocational training programs, their I.Q. scores, and the type of vocational training received. The response rate was higher for females, who are not included in the present study, and most of the differences appear to be sex-related.

[12]See Weitzman and Ono (14), Table 7, pp. 32-35.

[13]This property of the census data may be responsible for over-estimation of the influence of education on earnings. See Schwartzman (11) for a discussion of this and related issues.

[14]Perhaps mainly because we have created an approximation to 100% labor force participation through our high-quarter income measurements, while the untrained group has rising labor force participation with age during the late teens and early twenties.

[15]Chow's (5) equation (29) yields an F ratio for two regression equations. The null hypothesis that both groups of observations belong to the same regression model can be rejected when the computed F exceeds some critical value. The ratio is based upon the sum of squares of the errors from each of the two regressions and another error sum of squares from a new equation resulting from the pooling of the data sets underlying the first two. The numerator is determined by the difference between the pooled errors and the sum of the two separate errors, and the denominator is the sum of the separate errors.

[16]The age variables were entered into the regression to remove the influence of age by making each education group a residual of age; they have no direct interpretation in the analysis of the education-income relationship. It is likely that the age coefficients are signficant because of differences in labor force participation rates. (See footnote 14).

[17]See Al-Samarrie and Miller (1).

[18]During the period studies, the Tennessee Area Vocational-Technical Schools followed almost completely open admission policies and collected no tuition. Their ability to produce proportionate benefits for all their students should perhaps be considered in this light.

[19]Indeed our other tests indicated no significant association between prior level of educational attainment and duration of training or type of training received.

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